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Reclamation of Oil and Gas Well Sites on Privately-Owned Land in Alberta: An Evaluation of Benefits and Costs

By

Linda A. Bates ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of the requirements for the degree of Master of Business Administration.

FACULTY OF BUSINESS

Edmonton, Alberta
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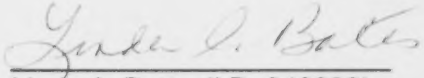

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The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Reclamation of Oil and Gas Well Sites on Privately-Owned Land in Alberta: An Evaluation of Benefits and Costs" submitted by Linda A. Bates in partial fulfillment of the requirements for the Degree of Master of Business Administration.

Dr. Allan Warrack

Dr. James Dunn

Dr. Terry Veeman

September 29, 1994

ABSTRACT

In Alberta, an estimated 24,000 oil and gas well sites will be abandoned over the next 10 years. There is concern by industry and others that the expense required to reclaim the surface lands at these sites to current standards represents a substantial opportunity cost to industry and the provincial economy. This thesis examines the economic benefits and costs associated with regulation of such reclamation activity; it also discusses the impact of surface access regulation on the reclamation process.

In recent years, researchers have examined the economic efficiency of government programs using Benefit-Cost Analysis (BCA), which quantifies the extent to which a program's benefits exceed its costs. Although this methodology lends itself to situations where variables can be identified and quantified, it is less easily applied where such is not the case. For example, as described in the relevant literature, BCA is not easily applied to environmental regulation where some extra-market benefits and costs are intangible and/or unmeasurable.

Although the results of this study are therefore qualified, it would appear that the costs of well site reclamation exceed the benefits. Costs are defined as reclamation expense; benefits are defined as the real estate value of the land, or alternatively as the net present value of agricultural land rentals. An effort has been made to provide a proxy for the extra-market value of the land to the landowner.

The continuation of full surface access compensation for nonproducing wells, and during the reclamation period can result in negative incentive effects that reduce allocative efficiency of reclamation regulation. Reclamation costs are correlated with well age and surface access payments, but not with agricultural land use or geographical region of the province. This suggests that reclamation standards designed to reclaim well sites to the same productive capability as land adjacent to the site is not driving reclamation effort. Rather, it appears that landowners that have negotiated substantial annual surface lease payments also may be demanding greater reclamation effort, either because of higher expectations or to maximize the period during which they receive full surface access compensation payments. Some methods of reducing these negative incentive effects to better attain reclamation objectives are suggested.

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INTRODUCTION

How Environmental Regulation Affects the Economy

Since the mid 1960s, increasing public awareness of environmental issues has resulted in greater governmental regulation of activities that damage or are perceived to damage the environment. Since the mid 1980s, such awareness has resulted in establishing and enforcing increasingly more stringent standards to prevent environmental damage (eg. pollution control), and goals for restoring land and water where damage already exists from past activities (eg. reclamation). As these measures become more stringent, costs of compliance increase. Compliance costs may also increase as a result of the choice of regulatory goal (eg. taxes vs. emissions standards).

Such regulations typically are enacted independently, by different agencies with different priorities who perceive a single action as falling solely within their regulatory mandate. It is exceedingly rare when any activity or industry falls only under the purview of one isolated agency. Multiple regulations may impose additional cost burdens and often result in conflicting goals. Where multiple objectives are presented within the overall regulatory framework, there will be an incentive for those being regulated to comply on a least-cost basis, and all regulatory goals, and possibly those of highest governmental priority, may not be met. If sufficiently large, the aggregate cost burden can affect an industry to the point where business

becomes unprofitable, and industry activity slows down, possibly with repercussions to the economy as a whole.

Ideally "all agencies that regulate a single product ought to formulate policy simultaneously, taking account of values to be set by other regulatory agencies."[1] In this way, it could be possible to determine an efficient level of regulation in aggregate, with the additional benefit of ensuring that all regulatory goals are mutually reinforcing. This approach would facilitate compliance with all regulatory goals, and mitigate the negative impact on the economy.

Hypothesis

In this study, there are two problems that will be investigated pertaining to regulation of access to, and use and restoration of privately-owned land that is required to be disrupted for drilling and production of oil and gas.

Hypothesis I: Reclamation Regulation

In Alberta there is an efficient level of well site reclamation regulation; that is, the net benefits to society are maximized by optimal regulation. To quantify whether efficient regulation exists, the benefits and costs of regulated activities will be examined using benefit cost analysis.

---

[1] Lave L.B., 1984. p. 473.

Hypothesis II: Surface Access Regulation

> There is an efficient level of regulation of access to privately-owned lands, such that the costs of compensation are equal to the loss incurred.

The thesis will conclude on whether the stated hypotheses can be supported or rejected, and if rejected, will provide some suggestions as to how current policy can be improved. Of specific interest is the relationship between the two regulations. A surface lease cannot be terminated until a reclamation certificate has been granted, since legal access is needed to effect the reclamation work. However, as a result, annual compensation is paid at the full rate, since rates are only negotiable on lease anniversary dates. The effect of this inadvertent "bundling" of regulations will be examined in detail in later sections of this paper.

Related Research

A number of researchers have investigated the impact of environmental regulation on the economy, much of which targets the non-renewable resource sectors. Hazilla and Kopp's studies of environmental regulation under the U.S. Clean Air and Water Acts showed a direct social cost of regulation in 1981 of $28 billion.[2] They also found that there are additional, indirect "dynamic" costs, which increase over time, resulting from negative impact on investment, capital stock and labour supply for industries that have as their inputs the higher cost products produced from highly

---

2 Hazilla, M. and R.J. Kopp, 1990. p. 865.

regulated industries.[3]

Jorgenson and Wilcoxin found that most of the long-run effects of pollution control and other environmental regulation were most pronounced for the motor vehicle and coal mining sectors, with primary metals mining and petroleum refining following closely behind.[4] Jin and Grigalunas investigated the degree to which additive compliance costs for multiple regulations affect a company's marginal costs of offshore oil and gas development in the U.S. Their findings show that in aggregate, a multitude of federal and state environmental regulations pertaining to all phases of exploration, development and production can increase costs to such an extent that marginal fields might not be developed, leading to a reduction in future energy supplies. In effect, for marginal fields, there is a shift in the regional supply curve upward and to the left.[5]

Kalt's study on the impact of choice of regulatory goal on compliance costs for reclamation required under the U.S. Surface Mining Control and Reclamation Act (1977) showed that under a standards approach, the costs of reclaiming lands in the Appalachian Mountains greatly exceeded the benefits. The high level of benefits obtained in the east is obtained at an even higher level of costs, leading to the conclusion that there is a deadweight loss created by the legislation. However, in

---

3 Hazilla, M. and R.J. Kopp, 1990. p. 866-871.

4 Jorgenson, D.W. and P.J. Wilcoxin, 1990. p. 336.

5 Jin, D. and T.A. Grigalunas, 1993. p. 94-95.

the west, where land is flatter and more easily reclaimed as well as less valuable recreationally and aesthetically, the standards-based regulatory solution is efficient.[6]

The best known and researched example of the effect of environmental regulation on the economy is Superfund, the environmental hazards clean-up program initiated by the U.S. government in 1980 under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Superfund is now authorized by the 1986 Superfund Amendments and Reauthorization Act (SARA), which directs the identification, evaluation and remediation of hazardous waste sites. Compliance costs are directly related to the regulatory goals, which may vary depending on the hazards encountered at each site.

Since SARA, compliance costs have doubled as compared to the 1980-1986 period, due in part to the need to comply with local and state regulations and assurance that the clean-up methodology is appropriate to the type of hazardous material.[7] These additional costs demonstrate the effect of multiple independent regulations of an industry or an activity based on standards as the regulatory goal. In achieving these standards, remedial strategies take into account the vulnerability, use and value of surface and groundwaters, and whether soil should be treated, covered or removed. Overall, there is a preference for more permanent (and therefore costly) solutions.[8]

---

6 Kalt, J.P., 1983. p. 911-914.

7 Baes, C.F. and G. Marland, 1988. p. 55.

8 Gupta, S. et al, 1993. p. 17.

In recognition of increasing costs, Superfund is now required to examine the cost-effectiveness of its options. Interestingly, the Superfund experience has shown that although the CERCLA administration is consistent in its choice of remedies for types of sites, uniform standards are not achieved in each clean-up because most sites are complex and unique.[9]

The issues related to benefits and costs associated with environmental remediation are not unlike traditional economic arguments questioning the validity of subsidizing irrigation. Research has shown that the value associated with subsidized irrigated water is small relative to the cost of providing it and relative to its other uses. Based on their research on the benefits and cost of irrigated water supply, Gardner and Huffaker state that "subsidized reclamation projects squander valuable capital and environmental resources by benefitting farmers far less than the taxpayers pay".[10] While their examples are based on the appropriateness of government subsidies (i.e. spending tax dollars), the argument is still valid if it is applied to the opportunity cost of private capital required to be expended by government regulation of industry activity. If capital is diverted from a more beneficial use (from society's point of view), then there is a net social loss.

The topic of this study is similar to these and other many environmental policy issues, where economic regulation (concerning specific industry practices) is

---

9 Baes, C.F. and G. Marland, 1988. p. 56.

10 Gardner, B.D. and R.G. Huffaker, 1988. p. 24.

combined with social regulation relating to the welfare of society. The interrelation of the two, and the ideology reflected in any policies designed to protect or restore the environment from a damaged state, create a difficult case for analysis. Nevertheless, efforts to attempt analysis and measurement of the impact of one or more policies are becoming more widespread. In Canada, recommendations by the Economic Council of Canada (1979) suggested that all new regulatory proposals be subjected to a form of benefit-cost analysis. Further, the Council recommended existing regulations be reviewed periodically to ensure that they continue to apply appropriately to specific objectives. [11]

As stated in the hypotheses, this study focusses on whether or to what extent are costs of reclamation compliance based on existing standards justified relative to the social benefits obtained. Further, to what extent surface access and reclamation regulations, both of which focus on the land associated with oil and gas extraction, are mutually reinforcing. This analysis will discuss the following factors:

- possible existence of incentive or avoidance effects, resulting in regulatory objectives not being achieved and thus signalling inefficient regulation; and
- the social welfare loss arising from inefficient regulation due to the choice of regulatory goals and/or and the policy instruments to achieve these goals either as a result of one regulation, or the combined impact of more than one regulation.

This study is limited to privately-owned land, which is assumed to be used primarily

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[11] Strick, J.C., 1994. p. 123-124.

for agricultural purposes.

SURFACE ACCESS AND ENVIRONMENTAL REGULATION IN ALBERTA

In Alberta, the ownership of land and the ownership of minerals underlying the land is only coincidentally the same. In fact, only about 20% of the land is Alberta is owned by people (or corporations) that also own the underlying minerals. For the remaining 80% of the land, the Crown owns the rights to the minerals, and authorizes any development and extraction through a complex set of statutes and regulations. The land overlying the minerals is subject to two different sets of legislation that can impose significant cost on industry: surface access regulations, and surface land reclamation policy. This study is limited to the impact of such regulation where the minerals are owned by the Crown, but the surface land is privately owned.

Through the 1970s, when prices for oil in particular were very high, compensation payments ratcheted upward. Since the mid 1980s, the oil and gas industry has suffered through cyclical periods of general price depression (Figure 1). Surface access lease payments, however, like other operating costs, have not fallen despite the considerably lower returns earned by industry subsequent to the 1986 price crash (Figure 2). As a result, the financial viability of companies, particularly the smaller producers, suffers and their ability to meet future reclamation responsibilities based on current or possibly more stringent standards is limited.

Figure 1. World Oil and Gas Prices, 1984 to 1993

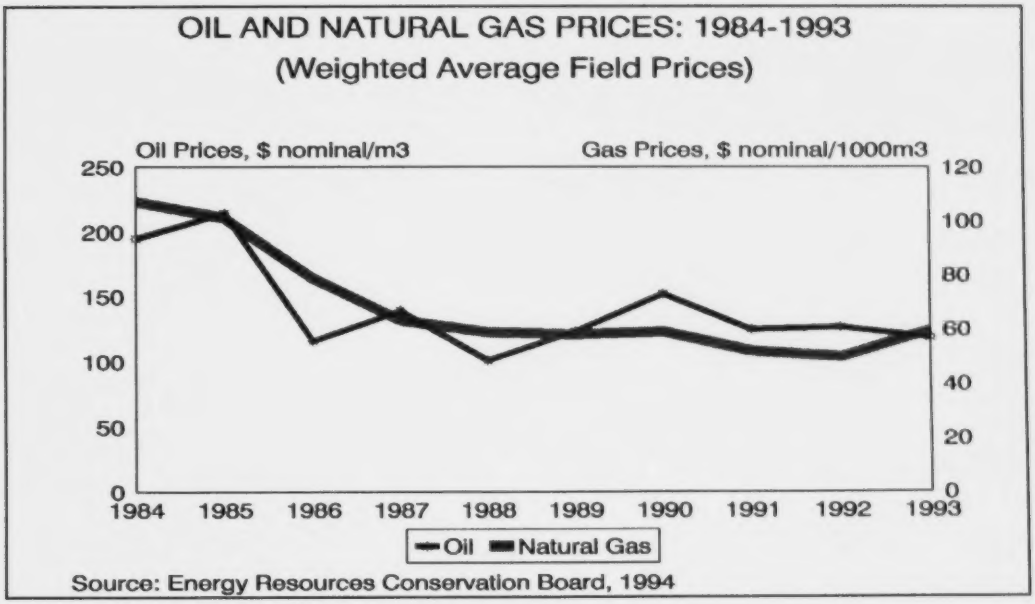
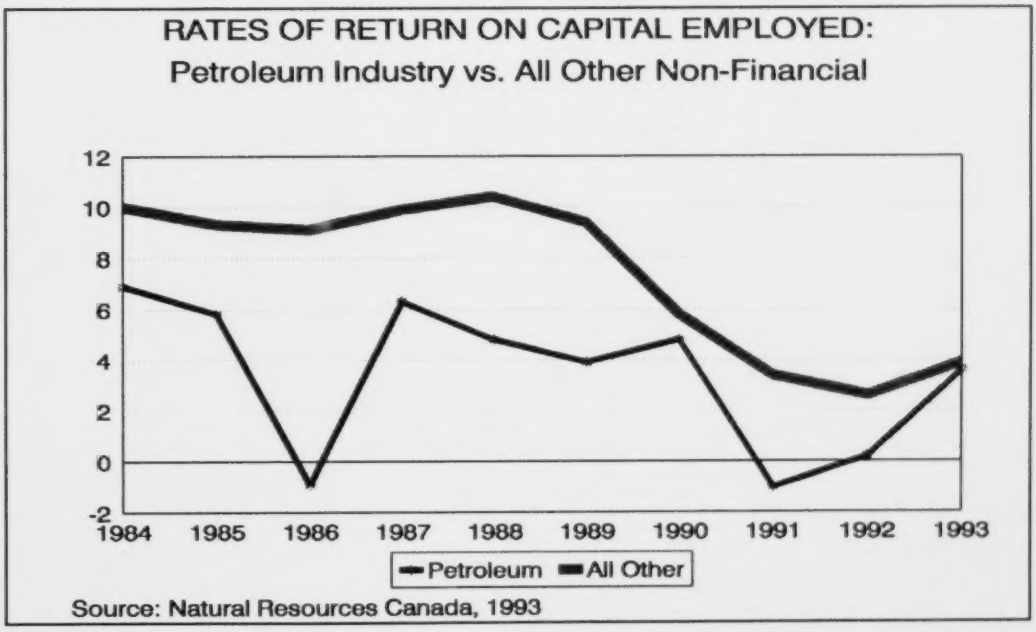


Figure 2. Rates of Return on Capital Employed



As of 1993, 77,370 wells had been abandoned in Alberta; 48,264 or 62% of these wells had received reclamation certificates. Of the remaining wells, some (the number cannot be determined from existing records) have had reclamation work completed or partially completed. It is estimated that between 1992 and 1995, over 24,000 wells will be abandoned and will require reclamation.[12] Some of the factors increasing reclamation costs include adverse topography, poor quality natural soils (eg. sandy, rocky or prone to erosion), climatic factors (e.g. dryness), loss of topsoil, compaction, and sites, where few if any conservation practices were followed (these are typically older sites, drilled between the 1950s and 1970s).

Surface Access Policy

Having acquired from the Crown the subsurface rights to explore and/or develop Crown mineral resources (eg. oil and gas), it is then necessary to obtain the surface rights to enter on private lands to drill wells. Although surface rights are not permitted by legislation to be withheld by a private landowner, compensation must be paid by the company wishing to drill, and such compensation to be negotiated by the parties.

The result of the negotiations is a surface lease agreement, which specifies the amount to be paid over the period of the lease. Should the landowner refuse entry,

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12 Land Resources Network, Ltd., 1993. p.14 , and Alberta Land Conservation and Reclamation Council, 1993. p. 1

the company can approach the Surface Rights Board, who will issue a right-of-entry order and set the terms of compensation under section 15 of the Surface Rights Act.

Surface access lease payments, whether made under private agreement or through a right of entry order, involves different categories of compensation. For all leases subsequent to 1983, there is an entry fee that is equal to the lesser of $5000 or $250 to $500/acre, depending on the total acreage under lease (section 19). The intent of the right of entry fee is unclear, but it would seem to be compensation for the landowner's relinquishing of his private ownership rights.

The amount of additional compensation is a fixed amount in the first year of occupation of the land, and a single annual payment thereafter. If compensation is set by the Surface Rights Board under a right of entry order, the amount of compensation is determined under section 25, with regard to the following factors. (These same factors also influence the setting of the annual lease payment under private surface leases.)

- the amount that might be realized if the land were to be sold in the open market;
- the value of the land in its highest approved use;
- the loss of use of the land to the landowner;
- any adverse effects on the surrounding land, and any nuisance, inconvenience and noise associated with the drilling and production activities;
- the damage to the land that may be caused by the actions of the company;

- costs incurred if the landowner is required to relocate his residence;
- damage that can be attributed by the company to lands not covered by the right of entry order, or to livestock or other personal property; and
- any other relevant factors.

While each item may not be addressed explicitly in private surface leases, the compensation generally reflects most of these items. For example, a typical surface lease mentions only the following (Appendix I):

> "(a) for the first year, the sum of ... which sum includes compensation in full for rental, severance, inconvenience, and damage to the demised premises ...
>
> (b) for each subsequent year, the sum of ... "

In this study, category (a) will be referred to as "initial" compensation, and category (b) will be referred to as "annual" compensation, or simply "surface lease payments". As noted above, subsequent to 1983, each lease would also provide for the payment of a right of entry fee.

The leases can be very short (<1 year for a well that is dry and immediately abandoned) or 30-40 years for productive wells. Compensation is required to continue until a reclamation certificate has been issued, at which point the lease is terminated. In the past, a reclamation certificate in most cases has not been issued until the landowner is satisfied that the land has been satisfactorily reclaimed. Should the landowner withhold approval, the company will be required to repeat the

work until it is satisfactory. Alternatively, the company can, if it feels it has met the compliance standards, apply to the Land Conservation and Reclamation Council for a Chairman's Certificate, which serves the same purpose as a Reclamation Certificate for purposes of terminating the lease. However, the process can be time-consuming.

Legal Issues Related to Surface Access Policy

The issue of compensation, and the involvement of government, stems from "Just Compensation Law", which broadly refers to "what general grounds justify programs interfering with the marketplace's apportionment of goods and services and why, if intervention is proper, compensation need ever be considered".[13] Compensation is concerned with the "taking" of something, which is considered to be any "publicly inflicted private injury." In terms of surface access regulation, the fundamental policy seems to be that the legislated provision of access to privately-owned lands for purposes of Crown mineral extraction constitutes a "taking" of that property, and accordingly, compensation is due. Although the principle seem relatively straightforward, the application of policy is less clear.

One of the first things to consider is whether the Crown is acting appropriately in legislating surface access. Since the outcome of the action is to create economic benefit for the province the Crown's regulation is considered to be economically

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13 Michelman, F.I., 1967. p. 1165.

rational, and is therefore justifiable because it results in "new conditions of resource employment [that] will produce a greater amount of welfare in society than the old one did. Improvement is unambiguously present only where gross benefits are shared to the point where no net losses have been sustained, and therefore compensation must be paid [to effect this]."[14] How should such compensation be defined?

Several factors are considered to contribute to the legal determination of compensation:

- whether or not physical takeover of an item occurs;
- the size of losses that may flow from the measure being proposed;
- the size of the "imposition" of the measure;
- the proportion of value of whatever item is affected (functionally as well as geographically if it is property that is affected); and
- in terms of utility theory, the demoralization costs, which are defined to be the money value of lost productivity stemming from the demoralization of uncompensated losers and their sympathizers who are disturbed by the thought that they might be subject to similar treatment.[15]

In the event of a physical takeover, Michelman suggests that a straightforward purchase price is due compensation; the remaining factors (except demoralization

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14 Michelman, F.I., 1967. p. 1168 and p. 1177.

15 Michelman, F.I., 1967. pp. 1179, 1189, 1191, 1192 and 1215.

costs) seem to define compensation as being some proportion of the overall value of the item in question. Demoralization costs are somewhat ambiguous; they may simply express the concept that the provision of compensation itself has value to people. Ultimately, Michelman provides no definition of how to determine compensation in actuality, but suggests that compensation is a matter of "justice as fairness". A person should be able to claim compensation in return for the taking of some object in the name of justice, regardless of the consequences on society as a whole. Again, the principle seems straightforward, until one actually has to calculate the compensation owing to the injured party (parties), and assess the total impact on society.

Legally, then, compensation is due when the public "takes" something that is private, and compensation is appropriate whether or not there is a direct cost in terms of net social welfare. The actual amount of compensation should be subject to negotiation, and quantification of the compensation should have some regard for the overall value of the item. This value presumably could be approximated by the market value of the item, or by some other means, which has not been explained.

Michelman assumes throughout his arguments that the item, once "taken" has zero salvageable value. A key issue that is not in the literature is how salvage value affects the determination of compensation, because it seems logical that this should influence the application of policy. This argument is relevant to both surface access and reclamation regulation in Alberta. Under surface access regulation,

compnesation is paid for the loss of the land, and associated "nuisance", with the land subsequently being returned to him, in most cases at almost full productive capability. In Alberta, the courts have recognized that there is in effect a system of "double compensation" whereby an individual may be compensated for the loss of his land only to have it restored.[16]

Environmental Policy

Upon termination of production of the well, but prior to termination of the lease, the well site is required to be reclaimed. Reclamation provisions may be found in some leases, but typically are absent. The enactment of reclamation legislation assumes that the reclamation of such lands is not solely a private issue, and that the standards of reclamation must reflect the public interest. The public interest represents more than just protection from health risk due to hazardous substances that may be present at these sites. It also implies a responsibility to maintain the land base.[17]

Following the 1990-1992 review of environmental iegislation, all reclamation and conservation regulations have been consolidated, and now exist as Part 5 of the new Environmental Enhancement and Protection Act, which came into force September 1, 1993 (replacing the former Land Surface Conservation and

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16 "Buchta v. Surface Reclamation Council", 1973, p. 586.

17 Larry Brocke, Chairman, Land Conservation and Reclamation Council, Alberta Department of Environmental Protection, personal communication, 1993.

Reclamation Act of 1980). "In general terms, it is safe to say that the new legislation has a considerably broader scope than did its predecessor, the provisions are more comprehensive and the liability is more severe. Fundamental concepts have been radically altered, marking a major shift in public policy as it relates to the preservation of the environment."[18] The reasons for such a shift in policy perspective are many, but globally represent a changing public attitude to which the political system must respond. "The fact is that the Canadian public has developed an increasing respect for the environment, and is actively expressing a demand for further and better protection through increased laws, penalties and regulatory action."[19]

One of the major new features of the new Act is that there is ongoing responsibility for reclamation subsequent to the issuing of a reclamation certificate, which formerly signalled the termination of the surface lease and any obligations of the company that had operated the lease. Now, this responsibility will continue for another 5 years. In addition, the "new legislation creates a statutory duty to reclaim, the failure of which is punishable, in the case of an individual by a fine of not more than $50,000 and in the case of a corporation of not more than $500,000."[20]

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18 Lalonde, K., 1992. p. 8.

19 Miller, S.R., 1993 , p. 3.

20 Miller, P.L., 1992. p. 1

A provision of the Conservation and Reclamation Regulations stipulates that the reclamation of surface lands includes all practical and reasonable methods. The regulatory goals, and the methods of achieving them are identified in the Department of Environmental Protection's "Conservation and Reclamation Code of Practice for Alberta" and "Reclamation Criteria for Wellsites and Associated Facilities" (1993) (Appendix II). The Code sets the standards for reclamation, which determine the level of reclamation of activity required, and thus costs.

The fundamental concept of the new Code of Practice is that the disturbed site should be returned to "a land capability equivalent to the pre-disturbance land capability", sustainable under normal management. It is also required that the predevelopment soil, landscape and vegetation conditions be accepted as the standard for postdevelopment conditions.[21] The Code will be applied through specific rules to be implemented and tested through the 1993 season.

Generally, the following activities must be undertaken by the company:

- any contaminants must be cleaned-up and disposed of or remediated in a manner that meets the Department's requirements;
- the landscape must be recontoured to its original grade and drainage, and erosion must be controlled;
- soils must be replaced in the same sequence as found before the disturbance unless otherwise directed;

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21 Alberta Department of Environmental Protection, 1993(b). p. 1.

- soil compaction must be corrected; and
- the site must be revegetated using approved species and weeds must be controlled.

"It takes approximately two years to ready an abandoned site for inspection and, if a problem is found, another two to correct it."[22] Nevertheless, every company can cite situations where some wells take significantly longer to reclaim, either because the remedial work is extensive and requires more time, or in situations where approval for the work is not provided, which may mean undertaking to obtain a Chairman's certificate, during which time full compensation is received by the landowner in the form of surface lease payments. In order to understand the application of the reclamation regulations, it is necessary to review the economic basis for government regulation.

ECONOMIC BASIS FOR GOVERNMENT REGULATION

Market Failure: Externalities and Public Goods

Where markets operate in perfect, or at least workable, competition there is little need for government to intervene. However, there are four instances where markets can fail: externality, public goods, common property resources, and monopoly. In these situations, government may undertake specific regulation to

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22 Pedersen, R., 1992. p. 23. Quotation by Doug Beddome, Senior Reclamation Officer, Southern Region.

mitigate the negative impact of market failure. In this study, the relevant sources of market failure are identified as externality and public goods.

Regulation of potentially harmful externalities such as environmental damage is desirable because the market provides inefficient and inadequate control. Indeed, the philosophy underlying the reclamation policy is the maintenance of the provincial land base, presumably for agricultural purposes. Without adequate reclamation regulation, the quantity of arable land would decline and agricultural productivity would suffer.

Public goods are classified based on the exclusiveness of ownership and the degree of "rival" use; that is, whether use of a good by one person diminishes its use by anyone else. Regulation of public goods is desirable to prevent overuse or waste.[23]

Externalities

An externality is defined as "a non-priced effect on a third party arising as a by-product of the actions taken by another. Externalities typically arise where there are no markets through which to price the effects and/or due to an absence of natural property rights".[24] Randall suggests that an externality, which is relatively short-lived

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23 Strick, J.C., 1994. p.23

24 Brander, J.A., 1992. p. 277 and p. 281.

because it can be resolved through mutual trade, should be considered separate from an inefficiency, which can persist and become the focus of mitigative government policies. Most other researchers do not differentiate between the terms externality and inefficiency, but concur that regulation occurs when mutual trade cannot resolve the problem: "externalities are attributable to the absence of the right to contract, [which] specifies the distribution of income and conditions of resource use ... and the margin of damage that is to be allowed."[25]

In this study, externalities are part of the reason for both regulations. In reclamation policy, the intent is to minimize the externality of environmental damage. In surface access policy, the intent is to compensate not only for the loss of the productive capability of the land being used for oil and gas production, but also to compensate for "nuisance" effects associated with the operation or simply the presence of equipment. Reclamation externalities are addressed solely through regulation; surface lands externalities are addressed through private contracts, which themselves are required by regulation.

Could these externalities be adequately resolved through private contract without the overriding authority of the statutes and regulations? It is unlikely, due to the high costs associated with contracting, and in particular, with dispute resolution. "The problem of social cost arises either in the absence of exclusive rights (absence of the right to contract) or where the rights exist, but where contracts are peculiarly

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25 Cheung, S.N.S., 1970. p. 50 and p. 56.

difficult to draw up...".[26] A similar argument could apply where contracts may be easily drawn up, but may be difficult to enforce. "The question is whether, given the same effects of an action, actual market contracts or realizable government regulations involve lower transaction costs so that a higher net gain or a lower net loss will result."[27] In this situation, transaction costs are defined to be the costs of contracting for transfer and enforcement of exclusivity of property rights.

Public Goods

Randall classifies "public good" resources based on the comparative degrees of rivalry and exclusiveness.[28] Nonexclusive resources are unowned; everyone has rights to them. Exclusive resources exhibit established property rights, which are enforced through law. Nonrival resources may be enjoyed ("consumed") by some without diminution of the amount effectively available for others, but such consumption of rival resources leaves nothing for others (Table 1).

Goods that are exclusive (categories 4, 5, or 6) can theoretically be provided by either the public or private sector, but the resulting allocation may or may not not be Pareto-efficient. This state of Pareto-efficiency or Pareto-optimality, which is fundamental to market theory, occurs when there is maximum efficiency in the use

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26 Cheung, S.N.S., 1970. p. 66

27 Cheung, S.N.S., 1970. p. 69.

28 Randall, A., 1992. p. 147.

Table 1. Randall's Classification of "Public" Resources

	Nonexclusive	Exclusive	Hyperexclusive
Nonrival	1	4	7
Congestible	2	5	8
Rival	3	6	9

1-3 These goods cannot be reliably provided by private sector, or by public sector financing them with user charges. Public sector provision through general funding is possible.

4-5 These goods can be provided by private sector or by public sector financing through user charges. Second best solutions may be achieved, but Pareto-efficiency is unattainable.

6 These goods could be provided by the private sector in a Pareto-efficient manner under certain conditions.

7 Nonrival goods could be provided by public or private sector at Lindahl prices[29], producing Pareto-efficiency.

8-9 These goods may in principle be provided in efficient quantities by the public or private sector. Hyperexclusion requires that the provider enjoy monopoly status. Pure profits may arise in violation of Pareto-efficiency with these goods.

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29 Lindahl pricing provides for an efficient amount of each good to be provided at Pareto-efficient prices because the price is different for each individual. Randall, A. 1993. p. 148.

of resources, as defined by the following conditions: prices must be equal to marginal costs of production, firms make normal profits, factors such as labour are paid the value of their contribution to production, and all factors seeking employment are employed.[30] Pareto-efficiency is attained when no further changes can be made to this system without harming someone.[31] Practical application of this principle usually requires that compensation be made (or is theoretically capable of being made) to any party who is disadvantaged by such a change in the economic system.

Randall's classification is useful in further analyzing the economic and legal, rationale for surface access regulation. If the land is considered a rival resource (oil and gas production precludes agricultural production), and surface rights are exclusive because they are privately owned, then land could be classified as category 6 in the absence of any regulation. That is, surface property rights are initially exclusive for all purposes, and in theory, could be provided by the private sector in a Pareto-efficient manner "under certain conditions". The intent of regulation would appear to be to ensure that "certain conditions" are always met.

If this is so, then land would remain classified as category 6, with the private sector retaining control over provision of adequate quantities of land for oil and gas development. However, it is suggested that regulation actually serves to reclassify land to category 9, creating "hyperexclusivity". The argument is that surface leases

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30 Strick, J.C., 1994. p. 20-21.

31 Zerbe, R.O. and D.D. Dively, 1994. p. 12.

create a captive supply for the company which has drilled a productive well on the site because there will be a desire to continue the lease, and this puts the landowner in an essentially monopolistic position. It is suggested that this situation does exist as a byproduct of the surface access regulation, and that it could, in fact, give rise to profit-seeking behaviour. In earlier years, when profits were high, companies earned profit such that the surface lease payments could be considered a normal return to a factor of production. However, in today's economy, very high surface rent payments can reflect above-normal profits earned by the landowners, which are inefficient.

The application of a public goods basis for reclamation policy is more general. The overall goal of reclamation is to maintain the land base for the "public good". It is presumed that the land serves as a factor of production for the agricultural industry, and has some additional, inherent value simply by virtue of existing. Accordingly, land may be viewed as being nonexclusive, falling into categories 1, 2 or 3. This category of resources cannot be reliably provided by the private sector, and hence the need for government intervention in the form of regulation to ensure that sufficient level of reclamation occurs.

Coase Theorem

Both externalities and property rights are central to the Coase Theorem. This theorem is traditionally used to define the extent to which an externality is likely to

persist in any economy (or in Randall's terms, become an inefficiency) and consequently the need for regulation. There are two versions of the theorem:

Strong version.

> Given a structure of property rights which is completely specified and exclusive, costlessly transferable, and costlessly enforced, voluntary exchange will eliminate all Pareto-relevant externalities and the resultant allocation of resources will be independent of the specific assignment of property rights. As a result, the Pareto-relevant externality is eliminated, while some Pareto-irrelevant (and therefore efficient) annoyance remains. However, these conditions are rarely met.

Weak version.

> Given a structure of property rights consistent with Pareto-efficiency, voluntary exchange will eliminate the Pareto-relevant externality and thereby establish an efficient allocation of resources[32].

The Regulatory Impact of the Coase Theorem

The allocation of property rights is critical as to whether or not trade will actually eliminate externalities. When rights favour the recipient, the externality is Pareto-relevant in its entirety, which means that greater gains could be made from trading,

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32 Randall, A., 1993. p. 151-152

and therefore more abatement could be required. This is the situation in the present study, where the landowner is the recipient of abatement activity for both damaged land externality (authorized by the reclamation regulations) and the "nuisance" externality associated with equipment and activity (authorized by the surface access regulation).

When rights favour the emitter, none of the externality is Pareto-relevant. This means that no benefit can be attained through trading, and therefore less abatement is required. "With respect to an external diseconomy, the specific assignment of rights does two things. First, it determines the directional flow of payments (if any) resulting from trade (if any). Second, given the magnitude of transaction costs and income effects, the assignment of rights determines how much of the annoyance persists at the completion of trade, i.e. how much of it is ipso facto declared Pareto-irrelevant".[33]

It is the specification of property rights then, that primarily serves to determine the initial distribution of income and wealth derived from land resources. Where externalities intrude, and in the presence of significant transaction costs, efficient exchange can be prevented that would otherwise enable resources to be made available for an alternative use through efficient exchange in order to maximize wealth. Policy to prevent such an economically undesirable situation may be designed based on one of two conceptual approaches derived from the Coase

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[33] Randall, A., 1993. p. 153

theorem:

Coase-Buchanan tradition

> The initial establishment of rights is followed by reassignment through voluntary exchange implementing strict Pareto-improvement criterion.

Coase-Posnar tradition

> Recognizing the asymmetry introduced by positive transaction costs, liability is assigned so as to minimize total costs or maximize aggregate the net value of product. As a result, where nonexclusiveness (and/or nonrivalry) exists, there would be direct government intervention to promote the result which most nearly satisfies the objectives of providing such goods in efficient amounts while minimizing transaction costs.[34]

The importance of the Coase Theorem, and in particular the Coase Posnar approach to regulation is to show that for goods that are exclusive and rival (such as the land resource in this study), an externality can be efficiently abated through voluntary exchange assuming no transaction costs. It is suggested that transaction costs to obtain land required for drilling and producing Crown minerals could, in the absence of regulation, be considerable and that a desire to minimize transaction costs is another reason for regulation.

For both reasons, the initial assignment of property rights has been adjusted through

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[34] Randall, A., 1993. p. 157.

government regulation. "[The] fundamental rules by means of which the members of a society assess the fairness of property rights arrangements are not independent of the effects those rules have on the creation of social wealth, defined as aggregate willingness to pay. In fact, we can and do assess the relative efficiency of alternative arrangements in order to determine, in hard cases, what is fair."[35]

The issue of transaction costs is central to the theory of "industrial organization" economics, which describes the institutional structure of production. "Organization is a matter of internal industrial (or agricultural) arrangement -- if not internal to the firm, at any rate internal to 'the' industry".[36] It is the institutional arrangements within an organization, which govern the process of exchange, and therefore the efficiency of the economy as a whole. Of primary importance are transaction costs, which are basically the costs associated with using the pricing system (eg. costs of negotiating contracts, product inspection, dispute resolution etc.). In a world of positive transaction costs, government intervention (in the form of regulation or other means) can produce a better result than relying exclusively on negotiation among individuals in the market for specific legal rights, which could be extremely costly.[37]

Having examined the normative rationale for surface access and reclamation regulation, it is important to assess quantitatively if the normative policy goals (what

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35 Heyne, P. 1988. p. 65

36 Coase, R.H., 1992. p. 713-714.

37 Coase, R.H., 1992, p. 717.

government "should" do in a given situation) are in fact accomplishing their intended effect. The following regulatory analysis will be based on benefit-cost analysis, although there are other methods that could be used. Some of these are presented in the next section.

Framework for Regulatory Analysis

To analyze the combined impact of these regulations, it is necessary to define the regulatory goals that are to be evaluated. Lave and Gruenspecht have identified five regulatory approaches, which incorporate, to varying degrees the following five policy goals:

- efficiency, which refers to both allocative efficiency (objectives that provide net social benefit) and technical efficiency (of input-output relationships);
- equity, the distribution of benefits and costs;
- administrative simplicity;
- transparency, the (perceived) likeliness of a project to achieve its stated objectives; and
- actual improvements in environmental quality.[38]

The five regulatory frameworks (presented below) that policy-makers can use in formulating the goals and objectives of social policy: no risk, technology-based standards, risk benefit, cost effectiveness, and benefit-cost. The reclamation

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38 Lave, L.B. and H. Gruenspecht, 1991. p. 681.

regulation is based on the first type of policy-setting, "no risk", which is also called the "standards-based" approach. This study focusses on the economic efficiency of this approach to regulation. The attributes of benefit cost regulation is also outlined below. There are some notable drawbacks to setting policy strictly on the basis of benefit-cost analysis. Nevertheless, it is a most useful tool in evaluating programs and policies to test performance.

No risk.

Specific discharge levels are established by regulation, with penalties for failure to comply. This approach improves environmental quality and is transparent, but does not include any of the other criteria.

Technology-based standards.

Regulations specify the use of best available technology or BAT. This approach ensures an improvement in environmental quality, and is administratively simple and transparent.

Risk-benefit.

Environmental quality is improved to some extent, with some consideration of least disruption and cost. For example, a regulation would allow discharge of the least harmful (risky) substance of several possible pollutants. There is less emphasis here on the criterion of improving environmental quality, since the choice could be made to ban the pollutant

entirely. Regulations made under this framework are less transparent, and would ignore (like those above) the equity and efficiency criteria. The risk-benefit framework has the serious problem in that the response may be entirely inappropriate, and may be subject to manipulation.

Cost effectiveness.

This approach emphasizes getting the most improvement in environmental quality for the money spent. It has the drawback of ignoring allocative efficiency and equity.

Benefit-cost analysis

This approach best addresses the criteria of allocative efficiency and technical efficiency, but it ignores equity (unless specifically modified to include this consideration). It is not simple, nor is it transparent. Moreover, it increases environmental quality only to the extent justified by the value of the environmental improvement.

The advantage of cost-effectiveness or benefit-cost analysis, which may be used in initial decision-making or to evaluate decisions made based on other approaches, is that the issues are explicitly defined. Both approaches can be manipulated, and benefit-cost analysis in particular is a controversial methodology as it is rooted in economic theory which traditionally is difficult to apply in a practical manner. Nevertheless, it can be shown that benefit-cost studies do serve to illuminate areas

where social loss may exist (even though its exact value may be subject to some degree of interpretation), and does identify all of the issues relevant to the regulatory impacts.

BENEFIT-COST ANALYSIS

Related Research

In their survey of current literature on benefit-cost analysis of pollution abatement regulation, Lave and Gruenspecht found that despite the difficulties in measuring benefits, at some point there is an observable trend where benefits of regulatory control begin to be exceeded by the costs. By demonstrating that very high marginal costs for these activities may exist, their conclusion is that these costs likely serve as an incentive for perverse behaviour, whereby abatement efforts are avoided.[39] In other words, incentive or avoidance factors, which serve to reward and therefore promote behaviour that is undesirable from the regulator's point of view. These effects can have significant efficiency costs.[40]

Obviously, a satisfactory benefit-cost analysis depends on substantial, accurate data that regulators most often do not have. This lack of information means that regulators seldom are able to ensure that an optimum amount of activity occurs (i.e.

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39 Lave, L.B. and H. Gruenspecht, 1991. p. 684-687.

40 Brander, J.A., 1992. p. 328-331.

where marginal costs are equal to marginal benefits). Lave and Gruenspecht suggest that regulators must instead choose among regulatory mechanisms with a view to minimizing the likelihood of an inefficient outcome. Their conclusions (supported by other researchers) is that "greater reliance on standard makes sense when the optimum is relatively insensitive to cost surprises and greater reliance on prices (through a tax) makes sense when the resolution of cost surprises is central to the determination of the desired control level".[41] Standards are popular both because of a (convenient) assumed insensitivity of the regulated activity to costs, and transparency to the public.

However, a standards-based approach may result in significant inefficiency. Kalt's study of the standards-based environmental legislation governing the U.S. coal-mining industry found that the actual results obtained under the legislation were inefficient on a regional basis. On an aggregate level, the benefits of regulation do not exceed the costs, and an observable trend suggests that the regulatory solution is inefficient on a regional basis because the cost of reclamation in the western states (eg. Montana, North Dakota) are less than the benefits, while the costs in the eastern states (eg. Appalachian Mountains) are much higher than the benefits, leading to the conclusion that there is a deadweight loss created by the legislation.[42] As a remedy, Kalt suggests that reclamation policy be revised to reduce efforts in the Appalachians and tax the damage that cannot be effectively avoided.

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41 Lave, L.B. and H. Gruenspecht, 1991. p. 688-689.

42 Kalt, J.P., 1983. p. 911-914.

Practical Application of Benefit-Cost Analysis

As seen from the Kalt example, benefit-cost analysis is typically a process of identifying and aggregating all of the benefits and costs attributable to a policy, and then determining if it is desirable based on its efficiency, as determined by a net social gain (benefit) or a net social loss (cost). However, the definition and calculation of the benefits and costs is not without difficulty. One of the key issues in current literature is the importance of eliminating transfer payments from the analysis because these do not measure efficiency. "Transfer payments measure the amount a regulatory change redistributes from losers to winners while changes in net surplus indicate the impact on the economy."[43] Changes in economic efficiency are measured by changes in producers' and consumers' surplus, through partial equilibrium modelling (based on an industry's supply and demand functions) or general equilibrium modelling (based on expenditure functions). Regulation almost always imposes costs, transfers, and benefits. However, quantifying social benefits may be problematic, particularly if they are intangible (cannot be seen or touched), or if they are tangible but have extra-market ("priceless") value.

Consumers' Surplus as a Measure of Social Welfare

Welfare economics attempts to determine how well off an individual or groups of individuals is after a change (to prices or incomes) as compared to before. As

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43 Hahn, R.W. and J.A. Hird, 1991. p. 236.

indicated above, practical application of welfare economics in the form of benefit-cost analysis is based on measurements of consumers' surplus and producers' surplus, as derived from industry supply and demand curves.[44]

Consumers' surplus is admittedly a simple concept (although it may be difficult to apply accurately), and therein lies its appeal to managers and policy-makers. In describing the usefulness of consumers' surplus, Harberger states that three basic postulates must be met:

> "(a) the competitive demand price for a given unit measures the value of that unit to the demander;
>
> (b) the competitive supply price for a given unit measures the value of that unit to the supplier;
>
> (c) when evaluating the net benefits or costs of a given action (project, program, or policy) the costs and benefits accruing to each member of the relevant group ... should normally be added without regard to the individual(s) to whom they accrue."[45]

Consumers' surplus generally is limited to partial equilibrium analysis, this is not a major obstacle to its use. However, there is one caveat regarding the use of consumers' surplus. "Consumers' surplus ... is meant to represent the benefit to a household from some change in price or prices, and any application must consider

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[44] Boardman, A.E. and A. Vining, 1994. Chapter 6.

[45] Harberger, A.C., 1971. p. 785.

that such a change would affect many households at the same time."[46] It is understood that such changes among different households would not necessarily be homogeneous. However, it is possible to ignore such distributional effects. In this study, average values will be used to reflect consumers' surplus, and differences between individual households will be ignored. It will be sufficient for specific policy redesign purposes to demonstrate through cost-benefit analysis whether or not consumers' surplus outweighs producers' surplus, thereby creating a net social benefit resulting from regulation.

An Alternative Welfare Measure: Compensating Variation

Hicks (1942) introduced measures of consumers' surplus based on compensating and equivalent variations in income or total expenditure (Table 2).[47] "The compensating variation is the money transfer which, following some economic change, would leave you as well off as before the change."[48] Measured using after-tax prices, compensating variation is typically used to indicate utility in money terms based on some type of consumer expenditure function.

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46 Bergson, A., 1980. p. 31.

47 Jorgenson, D.W. and D.T. Slesnick. 1985. p. 301.

48 Zerbe, R.O. and D.D. Dively, 1994. p. 78

Table 2. Compensating and Equivalent Variation[49]

	Compensating variation	Equivalent variation
	Money which can be taken or given to leave one as well off as before the economic change	Money which can be taken or given that leaves one as well off as after the economic change
Welfare gain (benefit)	Amount he would be willing to pay (WTP) for the change (finite -- limited by his income)	Amount he would be willing to accept (WTA) to forego the change (could be infinite)
Welfare loss (cost)	Amount he would be willing to accept (WTA) as compensation for the change (could be infinite)	Amount he would be willing to pay (WTP) to avert the change (finite -- limited by his income)

* WTA = willingness to accept; WTP = willingness to pay.

In this study, compensating variation will be useful in the benefit-cost analysis in a very limited application. The surface access lease payments to landowners are intended to provide compensation on an ongoing basis for disruption associated with oil and gas field operations. However, from the earlier discussion of incentive effects, it is clear that in some cases, a landowner and a company may agree that reclamation will not be undertaken on sites where the costs are too prohibitive. Instead, the company simply continues to make surface lease payments to the landowner. For purposes of analysis, these payments may be inferred to represent the utility that the landowner associates with the existence value of land in an undisturbed state; if it were worth more, landowner would refuse the payments and insist on reclamation.

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[49] Zerbe, R.O. and D.D. Dively, 1994. p. 80.

Methodology for Calculating Net Change in Welfare

This study evaluates the efficiency of surface access regulation and reclamation regulation, employing benefit-cost analysis. The evaluation will be limited to partial equilibrium analysis of economic benefits and costs. Partial equilibrium analysis assumes that only one market, that of the "production" of reclaimed land is affected by the policies, and that there are no price or income effects attributable to the economy as a whole as a result of reclamation activity. .

Welfare gain (or loss), in terms of reclamation regulation as discussed in this study, is consistent with other examples of "minimum quality regulation". Generally speaking, welfare gain is attributed to: "(1) the decrease in search costs, (2) the gain in product quality, and (3) the reduction in risk ... all of which serve to increase demand".[50] In terms of reclamation policy, the elimination of any health hazards, and the restoration of land to agricultural or other (but not oil and gas-related) use would represent welfare gain in terms of product quality and risk reduction. Hypothetically, a price increase would result relative to the price of land in an unreclaimed state. These potential welfare gains are assumed to be represented as consumers' surplus in the analysis of benefits and costs.

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50 Zerbe, R.O. and N. Urban, 1988. p. 5.

Elements of the Benefit-Cost Analysis

Zerbe and Dively suggest approaching the benefit cost analysis by calculating net change in welfare resulting from changes in consumer and producer surplus, government revenues and externalities.[51] The outcome will be a net positive or negative change in welfare which should theoretically satisfy the requirements for rejecting or not rejecting the initial hypothesis of the study:

Hypothesis I: Reclamation Regulation

> In Alberta there is an efficient level of well site reclamation regulation; that is, the benefits to society are maximized by optimal regulation.

Hypothesis II: Surface Access Regulation

> There is an efficient level of regulation of access to privately-owned lands, such that costs of compensation are equal to the loss incurred.

It is proposed that the analysis of benefits and costs for surface access regulation be limited to a comparison of the compensation (right-of-entry fee plus initial compensation plus annual compensation) to land values. It will be sufficient to show that if costs (compensation) significantly exceed benefits (value of the land), then there is some basis for reviewing the regulatory goals. Reclamation regulation will be subjected to a more extensive benefit-cost analysis, based on an evaluation of social welfare change, as expressed by Zerbe and Dively[52]:

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51 Zerbe, R.O. and D.D. Dively, 1994. p. 123-125

52 Zerbe, R.O. and D.D. Dively, 1994, p. 123.

$$\Delta W = \Delta CS + \Delta PS + \Delta GR + \Delta EE$$

W = welfare CS = consumer surplus

PS = producer surplus GR = government revenues

EE = external effects

To apply the equation to this study, some modifications must be made. Recognizing that surface access lease payments over the life of the well constitute an equivalent cost to the company and a revenue to the landowner, these payments are a transfer, and have been eliminated from the benefit cost analysis. These payments continue until reclamation is completed, and therefore continue to compensate fully for all externalities created by the existence of the well. Because externalities are fully compensated, they also have been eliminated from this analysis. There are no government revenues associated with these regulations, so this category of benefits does not appear in the analysis. Therefore, the welfare equation above can be reduced to:

$\Delta W = \Delta CS + \Delta PS$[53], and consequently **W = CS + PS.**

It is important to note that consumers' and producers' surplus are net amounts; consumers' surplus is the amount willing to be paid for a good (benefit) less the amount actually paid (cost), while producers' surplus is revenue (benefit) less production (cost). Hence, the above equation would provide the same answer as:

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53 Boardman, A.E. and A. Vining, 1994. Chapter 6.

W = Net social benefit = Gross benefit to society - Cost to society[54]

It should be noted that revenues and costs related to the drilling and production of the well are not relevant to this analysis of regulatory issues. The study focuses strictly on reclamation decision-making regardless of a company's profits or losses. Reclamation policy should focus on what is deemed to be an economically efficient level of reclamation activity for this industry and market.

Defining the Benefits and Costs of Reclamation

There are both tangible and intangible (or extra-market), direct and indirect benefits and costs[55]. Those direct and indirect costs that are tangible can be quantified, as they are generally observable. Those that are intangible must have some value imputed to them. Tangible costs may be calculated as consumers' surplus and producers' surplus based on industry supply and demand curves.

Figure 3 is typical of pollution abatement regulation where the supply curve corresponds to increasing marginal costs associated with increasing levels of regulatory compliance. The social loss is based on a departure from an optimum point as defined by price and quantity. For example, a movement from Q_1 to Q_2 creates a deadweight loss; no one is able to consume the product supplied. A

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54 Boardman, A.E. and A. Vining, 1994. Chapter 6.

55 Boardman, A.E. and A. Vining, 1994. Chapter 10.

movement from Q_1 to Q_3 creates a loss of consumers' surplus and producers' surplus because more would be consumed of a good, if it could be supplied. The calculation of the deadweight loss incurred In moving from Q_1 to Q_2, is the opportunity cost (area under the supply curve between Q_1 and Q_2) representing the producers' total cost, minus the area under the demand curve between these same points. For this demand and supply relationship to be applicable to regulated reclamation in Alberta, the supply curve would represent increasing percentages of land reclaimed, with an optimum point defined as the intersection with the demand curve, which would represent the value of the land.

Figure 4 more closely represents the situation encountered in this study, where the supply curve is vertical, because reclamation is not conducted on a progressive basis. The supply curve represents the quantity of 100% reclaimed land added to the provincial land base as a result of the regulation. Because regulation requires total reclamation, the supply curve is vertical, exhibiting zero elasticity. In other words, land is either reclaimed 100% or not at all; either a quantity of land is added to the provincial land base, or it is not. Again, a movement from an optimally determined point will result the same kinds of social loss as exhibited in Figure 3.

The notable feature of Figure 4 is the absence of producers' surplus, which would normally be the area above the supply line and below the (optimum) price line. In effect, the company has no surplus under this form of regulation; there is no profit derived from the production costs, it is all opportunity cost. Intuitively this makes

Figure 3. Supply and Demand: No Regulation

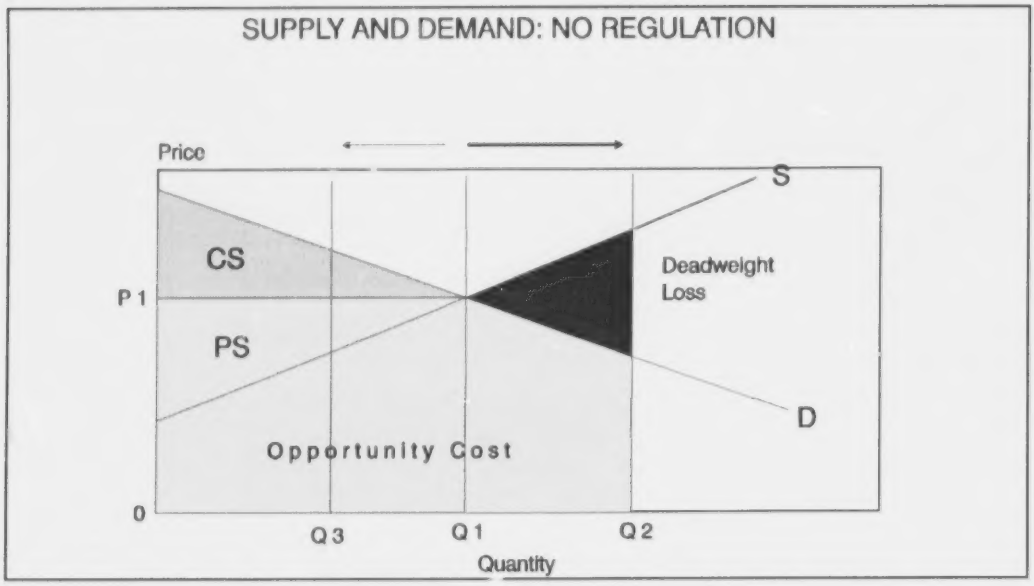
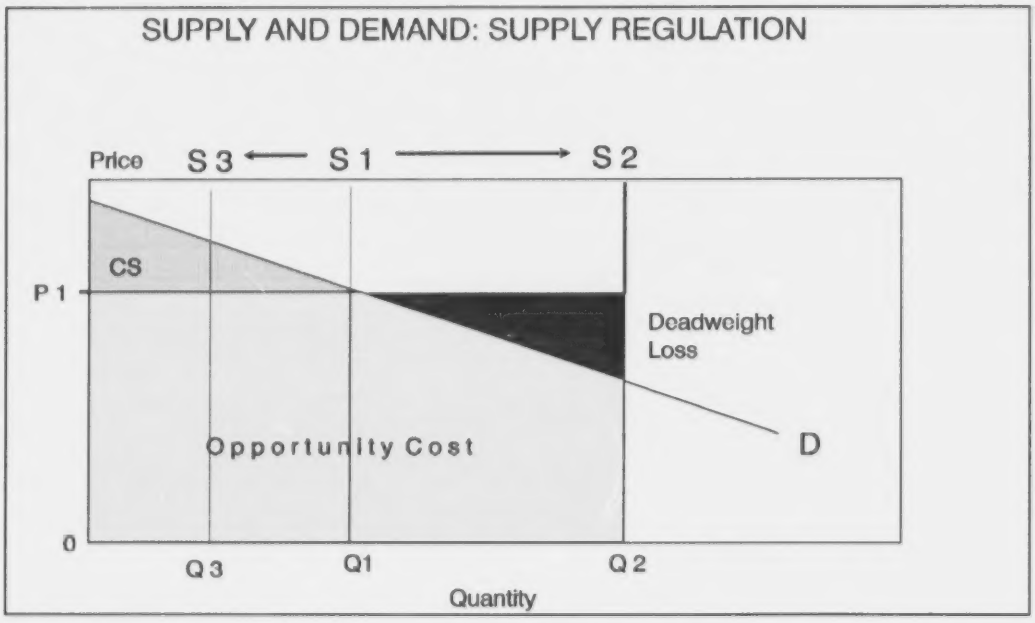


Figure 4. Supply and Demand: Supply Regulation



sense, because the reclaimed land is not a product that is to be sold by the company. The net consumers' surplus (CS) represents the social benefit achieved by the regulation over and above the costs incurred to obtain it. In this case, the deadweight loss is calculated by subtracting the area between Q_1 and Q_2 and below the demand line (consumers' surplus) from the area between Q_1 and Q_2 and below the price line (opportunity cost).

The demand curve in this study is defined to be the market value (price that consumers are willing to pay) of the arable land in terms of real estate values or the net present value of revenue that could be achieved by the landowner through leasing the land in return for a fee. Real estate values are the traditional means of ascribing a value to land.[56] It is understood, however, that "real estate values may understate land value as it does not necessarily account for all attributes of land", which includes its use as a factor of production and its amenity value.[57] Alternatively, it is possible to use the net present value of gross rental rates that are derived from leasing out land to someone else to be farmed. The logic for this argument is that the rental values are a better measure of return to farmland ownership than the real estate values, because they are in fact a major determinant of land value.[58] In this study, both real estate values and the net present value of land rentals are used as alternative measures of land value.

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56 Canning, P.N. and H.D. Leathers, 1993. p. 389.

57 Xu, F. et al, 1993. p. 356-357.

58 Kuchler, F. and A. Tegene, 1993. p. 431.

The benefits and costs can be defined as follows.

- Tangible Direct Benefits: increased arable land for cultivation or other use (consumer's surplus).
- Intangible Direct Benefits: "option" value of reclaimed land to landowner.
- Tangible Direct Costs: cost of reclamation activity (opportunity cost).
- Intangible Indirect Benefit: "existence" value of reclaimed land to the general public.

Existence and option values reflect non-use benefits and costs. "Option value" is defined to be the value that people ascribe to the land because they may have the opportunity or option to use it at some point in time. If an irreversible decision is made, this option is lost. The "existence value" of the land, is the value ascribed to it by people even if they know they will never use it.[59]

Quantifying the Benefits and Costs

The calculation of net social benefit requires firstly the quantification of producer and consumer surplus. While some data exists in the public domain to quantify demand in terms of land values, the information required to calculate costs is not publicly available; this primary data must be collected from the oil and gas companies performing the reclamation work. The methodology for this survey is presented in the next section.

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[59] Boardman, A.E. and A. Vining, 1994. Chapter 15.

No effort has been made to quantify the existence value of reclaimed land to the general public; this would constitute a major study in itself. For now, the value is assumed to be zero or very negligible. This is not an unreasonable assumption, since the privately-owned land that is the object of study usually has little recreational appeal, is not generally accessible by the public, and constitutes a relatively small site in the midst of a much larger undisturbed area.

An attempt has been made, however, to quantify the option value to the landowner of knowing that the land has been reclaimed. Although this value is probably quite secondary to the practical significance of restoring the land to agricultural productivity, it nevertheless is likely non-zero. To establish a proxy value, the discussion of compensating variation was revisited. It is suggested that where a company and a landowner agree to maintain the schedule of surface access lease payments without undertaking reclamation, that such payments constitute the willingness to be compensated measurement of this intangible benefit of option value. Although it is not known how widespread this practice is, it apparently does occur, based on discussions with study participants. In effect, the quantification of the option value is based on Hick's compensating variation, as follows:

If $CV = y' - e(v^0,p^1)$ where

y' = the post regulation income, and

e = the expense necessary to attain utility v^0 given commodity prices p^1 subsequent to a change.

Then $CV = e(v^0,p^0) - e(v^0,p^1) + y' - y^0$, where

y^0 = the pre-regulation income.

If, as in this study, there is no price change, then

CV $= y' - y^0$

= the amount of compensation as surface lease payments.[60]

Consequently, the net social benefit will be calculated as either:

Net Social Benefit = REV + OV - RE

REV = real estate value

OV = option value

RE = reclamation expense

or

Net Social Benefit = NPV Rent + OV - RE

NPV rent = net present value of future land rental payments

OV = option value

RE = reclamation expense

In both cases, consumer surplus is represented by the value of the land (however it is expressed), and opportunity costs are represented by reclamation costs. Reclamation cost data is only available from industry, and to complete this study, it was necessary to undertake a questionnaire survey of the oil and gas companies for purposes of gathering this primary data.

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[60] Hazilla, M. and R.J. Kopp, 1990. p. 862.

DATA COLLECTION: INDUSTRY SURVEY

Sample Population

This study was intended to gather very specific empirical data regarding industry experience. It is essentially an exercise in descriptive research, as it was intended to gather facts and statistics pertaining to surface access and reclamation costs, to obtain factual information, and to be able to interpret it in a meaningful way. However, beyond that, it was realized that assistance would be needed from the survey population to identify problems and issues related to these topics, not to merely provide statistical data.

Because data collection was only part of the goal of the study, the research procedure used to gather the study information is called an "experience survey" or the "key informant survey".[61] By its description, this type of procedure does not use a random sample of the general population to derive the survey population. Rather, interviews are generally held with key individuals that are familiar with the subject being investigated to gain their insights into to the relationships among data obtained in the study. Because the study would require a significant effort to gather extensive information, it was also felt that the sample population would necessarily have to comprise a committed group of knowledgeable individuals.

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61 Churchill, G.A. 1987, p.18 and 39.

Because this study would require the cooperation of industry for its completion, it was decided to approach the Canadian Association of Petroleum Producers (CAPP) in order to gain their support. CAPP members include all of the major, intermediate and junior oil and gas producing companies. It does not include the very small companies who belong to another industry organization called the Small Explorers and Producers Association of Canada (SEPAC). At the time of the study, initial discussions (September 1993) with CAPP staff and industry members indicated that the topic was of significant interest to them. CAPP had in fact presented their summary of the impact of surface access costs and reclamation costs to the then Minister of Energy, The Honourable Patricia Black.

CAPP approved of the study, and direct participation was offered through the Conservation and Reclamation Committee chaired by Ms. Sheri Meyerhoffer (CAPP's Manager of Industry Operations). Since the data required to be collected for the survey would be extensive, the need for insight and interpretation of issues would be important. Participation in the study through the committee was assured, the sample population was defined to constitute 100% of the committee members. Initially, 28 companies volunteered to take part on the survey when contact was first made with the Committee in September, 1993.

The survey was mailed to CAPP with a covering letter from Dr. Allan Warrack, Faculty of Business, University of Alberta, outlining the purpose of the study, and stipulating confidentiality of any information gathered for the study. The

questionnaire was distributed by CAPP to committee members. Follow-up telephone calls were made by the author as needed to verify information provided, or to enquire whether data would be forthcoming.

Questionnaire Design

The study was limited to well sites on privately owned land (i.e., did not include lands owned or leased by the Crown). The questionnaire (Appendix III) comprised three sections. It was intended to identify for each company, reclamation and surface access costs for wells that were in the process of being reclaimed in 1993 or which had been reclaimed in previous years but had not yet received reclamation certificates from the Department of Environment. There was a covering page attached to the questionnaire providing instructions for its completion, thanking participants for their assistance with the study, and providing an address for returning their responses, as well as the author's name, telephone and fax number.

The first part of the questionnaire was designed to gather physical data pertaining to the size of the well site to be reclaimed, the surrounding land use, the age of the well, its location in the province (legal land description), the period of reclamation required for the well (number of years), and type of well (gas or oil, suspended or producing). The second part of the questionnaire focussed on all surface access costs: the entry fee (if applicable), the initial year's compensation, the annual lease cost, and the duration of lease. The third part of the questionnaire requested data

on the types of reclamation activities that were undertaken and the costs attached to these activities.

Survey Response

The response to the survey was somewhat disappointing. Of the 28 companies surveyed, only the following six companies provided any data:

- Imperial Oil Resources Ltd. ("ESSO")
- Murphy Oil Company Ltd.
- Wascana Ltd.
- Sceptre Resources Ltd.
- Amerada Hess Canada Ltd.
- Norcen Energy Resources Ltd.

The data provided for a company's group of wells often was incomplete, in terms of the data requested for all three parts of the questionnaire (Table 3). In addition, it was found through the process of discussion with participants, that reclamation activities for some companies were largely undertaken in one year, and for others, the process stretched over several years. Consequently, companies had to be resurveyed by telephone for cumulative reclamation costs.

Table 3. Summary of Corporate Response to Survey

Company	Part I	Part II		Part III			
	Age	Initial Payment	Annual Lease	Local Land Use	Reclamation Activities	1993 Costs	Total Costs
Esso	No	No	Yes	No	No	Yes	Yes
Murphy	Yes	Yes	Yes	Yes	Yes	No**	No
Wascana	Yes	Yes	Yes	Yes	No	Yes	No
Sceptre	Yes	Yes	Yes	Yes	Yes	Yes	No
Amerada	Yes	Yes	Yes	Yes	Yes	Yes	No
Norcen	No	No	Yes	No	No	Yes***	No
NUL*	Yes	Yes	Yes	No	No	No	No

* NUL = Northern Utilities

** Murphy provided an average cost for all wells, not individual costs

*** Norcen's responses for each part of the questionnaire pertained to different groups of wells.

The main obstacle to gathering complete data was found to be the organizational structure of the companies themselves. The reclamation information was gathered and processed in a different area and by different staff than the surface lease information. Companies may have supervised the work, in which case data was fairly uniform, or they may have contracted the work to one or more consultants, in which case the data was quite diverse in terms of informational content and format.

Interestingly, companies' accounting systems seemed generally to be of little value in generating the summary type of information requested. Not only are companies

internally isolated with respect to the various functions related to land-based activities, their accounting systems also are apparently set up independently one from another. In some cases, massive amounts of surface access lease information had not been automated, and data could not be gathered because it involved manually accessing paper files, and staff were not available to do this.

Finally, the detailed information requested in the survey was often not supplied by the contact person sitting on the CAPP committee who had offered to participate in the study. Rather, it was left up to the field staff, located throughout Alberta, to provide the information requested. These individuals in many cases failed to complete the questionnaire. Where companies failed to be able to complete the questionnaire they appeared to genuinely regret not to be able to participate in the study.

SURVEY RESULTS

Part I: Well Data

A total of six companies responded to this portion of the questionnaire, which was intended to establish the average size of reclamation areas, and the type of well (Table 4). It had been intended to compare reclamation costs between oil and gas wells, but this was not able to be done as cumulative cost data was not supplied by all companies.

Table 4. Physical Data Pertaining to Well Sites

Company	No. of Wells	Type of Well*	Average Site Area (hectares)	Average Site Area (acres)
Esso	248	non-pr. oil	1.2	3**
Wascana	9	3 pr. gas, 4 non-pr gas, 1 D&A	2.15	5.36
Sceptre	29	non-pr. oil	1.21	3.04
Murphy	24	11 pr oil, 12 non-pr oil, 1 D&A	1.06	2.64
NUL	9	non-pr. gas	1.3	3.25
Amerada	3	1 non-pr. gas. 2 D&A	2.3	5.7
Average Size (excluding Esso)	78		1.26	3.16

* Type of well: pr = producing, non-pr = not producing (suspended or abandoned); D&A = dry and abandoned

** Average size as provided by the Esso respondent

The Esso respondent did not identify the well types; this information was obtained from Energy Resources Conservation Boards non-confidential records using an on-line database. All wells in Table 4 were either completed in 1993 or had work ongoing. No wells completed in previous years were included in the survey, or if they were included, they were eliminated.

Part II: Surface Access Costs

All companies provided some information of surface access costs, however, most often only current lease payments were provided. It had been intended that the

study provide some idea over what period such payments were made. Of the companies that responded, only Esso and Norcen were unable to provide a commencement date for the leases. Tables 5 and 6 provide a summary of the range in values of the annual surface lease payments and right-of-entry fees by company. Murphy Oil and NUL provided a time series of lease payment changes for the wells in their submission; these are presented in Table 7.

Part III: Reclamation Costs

Esso provided the most complete cumulative cost data, although the remaining data was limited. All companies except NUL provided 1993 costs; however, Norcen's reclamation cost data was for a different set of wells than the surface lease cost data. Neither Esso nor Norcen were able to provide a description of the surrounding land use, which normally determines, to a great degree, the level of reclamation work required. A summary of the land use provided by the rest of the respondents is presented in Table 8.

Since surrounding land use information was not provided for the Esso wells, which exhibit the most complete cost data, a proxy has been used to determine suitability of land for agricultural use. The proxy that has been selected is the Canada Land Inventory (CLI) land classification. CLI maps were examined for each well in the study, and a weighted average value was calculated for each well. While it is recognized that this is necessarily imprecise, there were few other options available.

Table 5. Current Surface Lease Rates of Payment ($1993 per site)

Company	Lease			Average Total Compensation*	Well Age (yrs)
	Average	Minimum	Maximum		
Wascana	$1899	$240	$2025	$8563	5.7
Sceptre	$2029	$290	$3530	$30120	12.5
Murphy	$1861	$750	$2500	N/A	15.6
Amerada	$2367	$2100	$2700	$16271	5.5
Esso	$1803	$0	$6000	N/A	35.2
Norcen	$1641	$230	$2600	N/A	N/A
NUL	$2272	$1600	$2900	$30860	16.9

* Surface lease payments plus initial compensation, nominal dollars (as spent)

Table 6. Range in Initial Compensation Payments ($ Nominal, per site)

Company	Minimum	Year	Maximum	Year
Wascana	$65	1970	$4500	1982
Sceptre	$1957	1979	$11295	1983
Murphy	$0	1976	$5700	1982,1983
Amerada	$5515	1989	$10800	1987
Esso	N/A	N/A	N/A	N/A
Norcen	N/A	N/A	N/A	N/A
NUL	$927	1955	$13436	1977

Table 7. Annual Surface Lease Rental Rates: 1970-1993 ($ Nominal, per site)

Company	1970	1975	1980	1985	1990	1993
Murphy	N/A	$217	$697	$1699	$1878	$1880
NUL	$214	214	$1338	$2122	$2228	$2272

Table 8. Land Use at Well Sites

Company	Cultivated		Unmodified	
	Crops	Grazing	Grazing	Nonagriculture
Wascana	33%	33%	22%	12%
Sceptre	64%	36%		
Murphy	86%		10%	4%
Amerada	33%	67%		
Total	66.1%	24.2%	6.5%	3.2%

The CLI classification often rated the land based on overall proportions of up to three different classes. The weighted average CLI classification was calculated to facilitate comparison among wells using a single number in computer spreadsheets.

BENEFIT-COST CALCULATION

Analysis of Surface Access Compensation

As discussed, surface access compensation may be analyzed using benefit-cost techniques assuming that benefits are the value of the land and costs are the compensation payments. As shown in Table 9, using only annual surface lease payments to proxy cost, and using either real estate values or NPV land rental values to proxy benefit, the costs of surface access exceed the benefits.

Table 9. Benefit Cost Results: Surface Access Regulation

Class	NPV Rental	Real Estate	Avg. Surf. Lease*	Rental - Lease	Real Estate - Lease
1	$294	$830	$613	- $319	$217
2	$312	$623	$674	- $362	- $51
3	$296	$465	$506	- $210	$41
4	$290	$490	$568	- $278	$78
5	$286	$464	$564	- $278	$100
6	$302	$344	$924	- $622	$580

However, the hypothesis is that compensation is set at an efficient level such that it equals the damages incurred. If we assume complete damage to the land, which does not occur except in very rare circumstances, then the value of this loss is also the NPV land rental or real estate value. Consequently, it can be concluded that the level of compensation is not set at an efficient level, based on the tangible benefits and costs ascribed to the land. It is possible that there are intangible values (benefits) that could increase that side of the equation, however, it is unlikely that such an increase would offset the total compensation that is required for each well site (right-of-entry fee, initial compensation, and cumulative annual surface lease payments over many years).

Analysis of Reclamation

The calculation of benefits and costs attributable to reclamation is shown in Table 10, using both NPV of land rentals and real estate values. As with the compensation analysis above, all data is for Esso, and consequently represents only one company. Wells were eliminated from the study that did not exhibit complete data for costs and values.

Table 10. Benefit-Cost Calculation for Each Land Class ($1993/acre)

Class	Rec. Costs	NPV Rental	Real Estate	Max. Surf. Lease*	B-C (Rental)	B-C (Real Estate)
1	$5519	$294	$830	$2000	-$3225	-$2689
2	$5365	$312	$623	$2000	-$3053	-$2742
3	$2992	$296	$465	$2000	-$696	-$527
4	$4873	$290	$490	$2000	-$2583	-$2383
5	$5536	$286	$464	$2000	-$3250	-$3072
6	$5372	$302	$344	$2000	-$3070	-$3028

* The maximum surface lease payment for ESSO is $6000 per site, or $2000/acre

The NPV land rental values are discounted annual rental rates derived from data published by Albert Agriculture, Food, and Rural Development. The rentals were inflated for 50 years at a rate of 1.2% (which assumes that rate on inflation for 1992-1993 holds for the duration of the period). The discount rate was 8%, which reflects

current levels of inflation and interest rates. The 50 year period was selected as appropriate, since running the NPV calculation beyond 50 years resulted in a change to the NPV value of less than 2%.

Interpretation of Results

Based on these results, a response to the original hypotheses is possible.

Hypothesis I: Reclamation Regulation

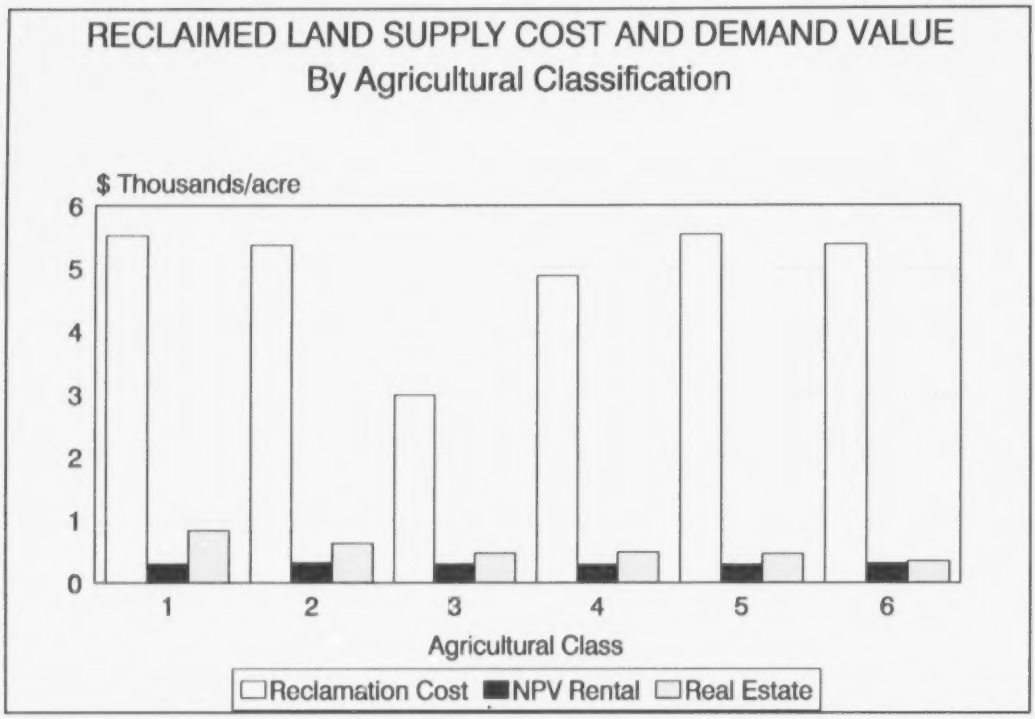
In Alberta there is an efficient level of well site reclamation regulation; that is, the net benefits to society are maximized by optimal regulation.

Response

Based on the data available, this would seem not to be the case. There are significant costs incurred that do not produce a similar level of benefit. There are some qualifications to the conclusion (below). However, such a level of activity would be justified if it could be shown that the variable that has not been included in this analysis, the positive existence value of the land to the general public, is equal to the negative value of the net cost. Alternatively, if it could be shown that the option value of the land to the landowner exceeds the proxy of the surface lease remuneration, then this level of cost could be justified. However, it is clear that in most cases, this difference would have to be quite large to result in an economically efficient solution. This is not to say that such a result is not possible. Rowe et al (1980) found that compensation for lost amenity values were an order of magnitude larger

than willingness to pay to avoid such a loss.[62] Figure 5 is based on the same data as Table 10, and shows the supply cost and demand value for land that is reclaimed under regulation.

Figure 5. Reclaimed Land Supply Cost and Demand Value



In terms of standard supply and demand concepts, this situation of costs greatly exceeding benefits, with inelastic supply and demand curves is presented in Figure 6. In effect, what is shown is a deadweight social loss "rectangle".

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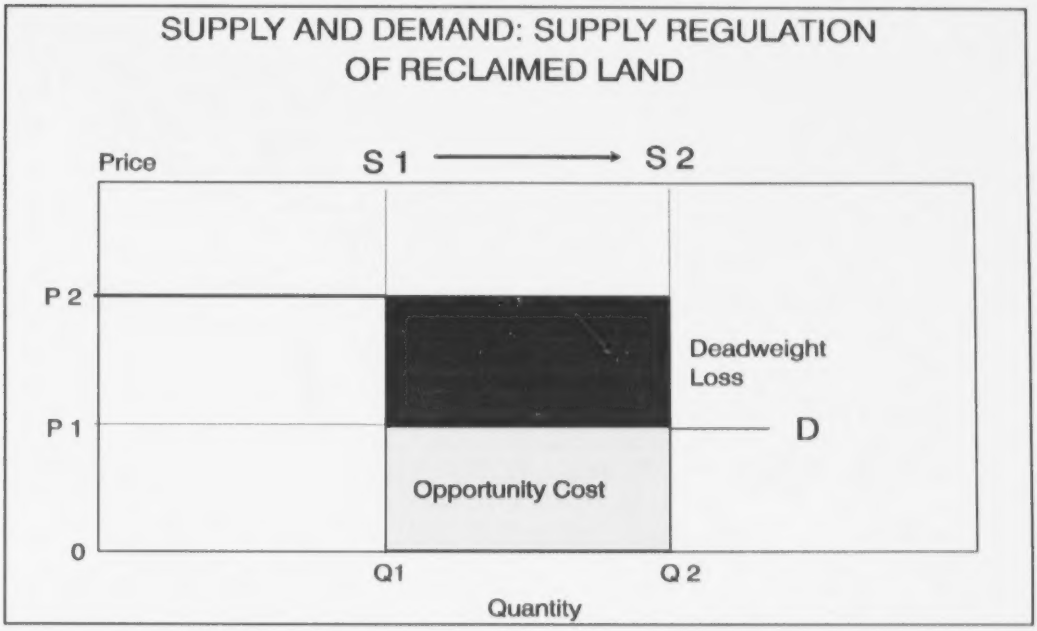
62 Rowe, R.D. et al, 1980. p. 14.

Figure 6. Supply and Demand: Regulation of Regulation



Hypothesis II: Surface Access Regulation

There is an efficient level of regulation of access to privately-owned lands, such that costs of compensation equal the loss incurred.

Response

This would seem not to be the case. The costs incurred for surface lease payments are much higher than the value of the land, which if the assumption of zero salvage value (i.e. total damage) were to be accurately applied, would suggest that the maximum total compensation payable would be the value of the land. The data shows that past negotiation has resulted in high payments, thus compensation exceeds the actual value of the land, even assuming 100% damage. Consequently, compensation is set at

inefficient levels based on an analysis of tangible variables. One might conclude, then, that the excess cost reflects the intangible value of the externality. The dependence of surface access regulations on reclamation regulations will be examined in the following section on Positive Policy Analysis.

Qualification

It should be noted that the average values presented in Table 10 and Figure 5 are derived from data that does not necessarily exhibit a normal distribution. As shown in frequency distributions (Appendix IV) some standard deviations are very large, and the average values should be interpreted with caution.

POSITIVE POLICY ANALYSIS

Positive analysis of government policy by definition focuses on the "objectives, behaviour, and interaction of individuals and groups who influence policy decisions. Instead of focusing on what policy should be, as normative analysis does, positive analysis examines the reasons why policy takes the form it does. Incentives facing policy makers are created by two major external forces: voting patterns and lobbying by special-interest groups. Both of these external forces affect the self-interest of policy-makers. In addition, policy-makers have personal direct self-interests that

affect the conduct of policy,"[63] In this study, positive analysis may explain why reclamation regulation and surface access regulation persist in their current form, and in particular, may explain whether or not incentive effects are present that reduces the efficiency of regulation.

Incentive Effects

Incentive effects and avoidance behaviour can greatly lessen efficiency, therefore increasing economic costs of any policy. They generally involve taking advantage of the benefits of a policy or avoiding the negative consequences respectively. In this study, several examples of negative incentive effects are suggested based on discussions with survey respondents:

- Landowners may achieve greater revenue by continuing the annual surface lease payments than they would from farming the land subsequent to its reclamation. There is a strong incentive for landowners to refuse to approve reclamation certificates, thus preventing the granting of reclamation certificates. In such cases, the environmental goals are not met, and the "justice as fairness" foundation of the compensation system is compromised. There is recourse to the Land Conservation and Reclamation Council, through which a Chairman's certificate may be granted authorizing the company to terminate the lease, however, this is a time-consuming process. It would greatly improve policy application if the incentive for this behaviour

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63 Brander, J.A. 1992, p. 5.

were simply removed.

- This same incentive can create another problem. If a site has suffered severe damage, and will be very costly to reclaim, then a company may simply continue compensation payments to the landowner, and reclamation work may never be undertaken. As above, the environmental goals will not be met.
- In some cases, individuals may undertake grazing leases on Crown land for purposes of entitlement to receive compensation payments. Agricultural activity may not be undertaken at all, or only on a notional basis. As a result, this land is withheld from others who may want to legitimately use it in a productive agricultural capacity.

Hypotheses

The following positive analysis will consist of testing a series of hypotheses using regression analysis to determine whether specific costs and other factors show any correlation that might indicate a causal relationship. The data is the same as was used to perform the cost-benefit analysis. The hypotheses to be tested are that reclamation costs are correlated with each of the following factors:

- agricultural land classification (representing the inherent agricultural value)
- agricultural region
- surface lease payments
- age of the well

- real estate or NPV agricultural rental value (representing its value for agricultural or other use).

Statistical Analysis

Simple and multiple linear regression will be used to test the following correlation hypotheses. All work was performed on a Lotus spreadsheet using the Lotus regression application. The original sample of Esso wells was reduced for the simple linear regression and for the multiple linear regression to exclude four wells for which no age data was available. If these were not excluded, the Lotus software application reads blank or N/A labels in cells as zeros, thus creating errors in the analysis.

The goodness of fit for each regression is provided by the R^2 value. Since the sample comprises cross-sectional data rather than time series data, a large R^2, indicating a good fit, is not necessarily expected. Therefore as an additional measurement, the coefficients are also tested for significance. For simple linear regression, the t-statistic was used (X coefficient divided by the standard error of the X coefficient).[64] All hypotheses have been structured such that the null hypothesis, which states that the X-coefficient is zero (implying that no correlation exists) is to be rejected if the t-test statistic exceeds the critical value, and is not to be rejected is the statistic is less than the critical value. Using a one-tailed t-test at the 95%

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64 Anderson, D.R. et al, 1990. p. 572-573.

confidence level (α = .05) and ∞ degrees of freedom, the critical value determining whether or not the null hypothesis is rejected is 1.645. Data was also tested at the 90% confidence level (critical t value = 1.282). A one-tailed test is used because in this data set, there are no negative values for any of the X variables.

The null hypothesis (below) states that if $\beta = 0$, then the independent variable x is not useful in explaining variability in the dependent variable y. If the t statistic is larger than the critical value, then the null hypothesis can be rejected, indicating that the independent variable does explain some of the variability in the dependent variable (reclamation costs). The decision rule for simple linear regression is:

Reject H_0: $\beta_1 = 0$ if $t > 1.645$.

The F-test for multiple linear regression is calculated based on the following formula in Harnett[65]:

$$F = \frac{(SSR \div m \text{ degrees of freedom})}{(SSE \div n\text{-}m\text{-}1 \text{ degree of freedom})}$$

where $SSR = \sum(\hat{y}_i - \bar{y}_i)^2$

$SSE = \sum(y_i - \hat{y}_i)^2$

m = the number of coefficients being estimated

n = the number of observations in the sample.

At a 95% confidence level (α = .05), the critical value of F for 5 degrees of freedom in the numerator and ∞ degrees of freedom in the denominator is 2.21; for 3 degrees

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65 Harnett, D.L., 1975. p. 416-417 and Table VIII(a)

of freedom in the numerator and ∞ degrees of freedom in the denominator, the critical value is 2.60. In all cases of regression, the y (dependent variable) is reclamation costs. The decision rule for multiple linear regression is:

Reject H_0: $\beta_1 = \beta_2 = ... = 0$ if $F > 2.21$ or 2.60, as appropriate.

Reclamation Costs vs Agricultural Classification

It is suggested that the greater the ability of the land to support agriculture, the easier it will be to reclaim, therefore there should be some correlation between reclamation costs and agricultural classification. This hypothesis is based on an intuitive observation that lands that are highly desirable for agriculture will also be the easiest to reclaim, because presumably they will be flat, of moderate climate, and (provided adequate topsoil still exists), capable of growth. All of these factors should facilitate reclamation.

Table 11. Results of the Linear Regression: Agricultural Classification

Y = reclamation costs and X = agricultural classification	
Constant	5137.96995
Standard Error of Y estimate	3069.89313
R^2	0.00594364
Number of Observations	205
Degrees of Freedom	203
X Coefficient (β)	-167.20946
Standard Error of the X Coefficient	151.772137
t statistic	1.1017138

If this hypothesis is not supported by the data, it is possible that no relationship exists, or that other factors such as poor land use practices reduce the correlation. The results of the simple linear regression analysis are presented in Table 11. Since the t statistic is not larger than the critical values at either the 95% or 90% confidence levels, the null hypothesis cannot be rejected, and it must be concluded that agricultural classification is not useful in explaining variability in reclamation costs.

Reclamation Costs vs. Agricultural Region

It is suggested that reclamation costs will be correlated with agricultural regions as shown in the map included in Appendix V due to standards not being enforced uniformly across the province. This hypothesis suggests that the self-interests of the policy-makers (or those that enforce policy) are driving the reclamation decision-making, creating more activity (and higher costs) in some areas as opposed to others.

Table 12. Results of the Linear Regression: Agricultural Region

Y = reclamation costs and X = agricultural region	
Constant	5543.25866
Standard Error of Y estimate	3073.51089
R^2	.00359934
Number of Observations	205
Degrees of Freedom	203
X Coefficient (β)	-197.88652
Standard Error of the X Coefficient	231.086106
t statistic	0.08563324

The results of the simple linear regression analysis are presented in Table 12. Since the t statistic is not larger than the critical values at either 95% or 90% confidence levels, the null hypothesis cannot be rejected, and it must be concluded that agricultural region is not useful in explaining variability in reclamation costs.

Reclamation Costs vs Surface Lease Payments

It is suggested that reclamation costs will be higher for those lands where surface lease payments are also above average. This hypothesis suggests that landowners may be seeking excess rents by withholding approval of reclamation efforts in order to continue surface access payments, resulting in repeated effort and higher overall costs. Alternatively, landowners who exact the highest surface lease payments through negotiation may also be the same individuals who (through "hard bargaining") drive the reclamation decision-making directly (through discussions with the company or reclamation officers), or indirectly by withholding approval.

Table 13. Results of the Linear Regression: Surface Lease Payments

Y = reclamation costs and X = surface lease payments	
Constant	3440.07729
Standard Error of Y estimate	3021.72078
R^2	0.03689606
Number of Observations	205
Degrees of Freedom	203
X Coefficient (β)	2.07108654
Standard Error of the X Coefficient	0.74267155
t statistic	2.78869782

The results of the simple linear regression analysis are presented in Table 13. Since the t statistic is larger than the critical values at both 95% and 90% confidence levels, the null hypothesis can be rejected, and it must be concluded that surface lease payments are useful in explaining variability in reclamation costs.

Reclamation Costs vs Well Age

It is suggested that the major factor affecting reclamation costs is the age of the well, since very old wells were drilled without regard for topsoil conservation or other more modern approaches to minimizing land damage through the drilling and production process. Further, some of these old wells suffered spills of salt or toxic drilling mud, and so require greater expenditure. Finally, drilling muds used in the past were considered to be more toxic than the muds which have been developed in recent years. If this hypothesis is supported by the data, then there is good reason to maintain the existing policy, regardless of costs, due to the need to prevent health risks.

Table 14. Results of the Linear Regression: Well Age

Y = reclamation costs and X = well age	
Constant	5826.47844
Standard Error of Y estimate	3065.06096
R^2	0.01342139
Number of Observations	201
Degrees of Freedom	199
X Coefficient (β)	-30.400389
Standard Error of the X Coefficient	18.4765008
t statistic	1.6453542

The results of the simple linear regression analysis are presented in Table 14. Since the t statistic is equal to the critical value at the 95% level of confidence, and exceeds the critical value at the 90% level of confidence, the null hypothesis can be rejected, and it must be concluded that well age is useful in explaining variability in reclamation costs, although the significance level is borderline.

Reclamation Costs vs. Land Value

It is suggested that the major factor affecting reclamation costs is the value of the land for agricultural or other use. This value is defined to be the real estate value (willingness to pay for the land) or the net present value of an appropriate agricultural rental. Presumably, people holding higher value will want to preserve its value through higher than average levels of reclamation effort. The results of the simple linear regression analysis are presented in Table 15.

Table 15. Results of the Linear Regression: Land Value

Y = reclamation costs and X = land value		
	NPV Land Rental	Real Estate
Constant	3457.97719	2797.51867
Standard Error of Y estimate	3073.42189	3012.72848
R^2	.00365705	0.04261971
Number of Observations	205	205
Degrees of Freedom	203	203
X Coefficient (β)	4.05218165	3.18561922
Standard Error of the X Coefficient	4.69440029	1.05969971
t statistic	0.86319474	3.00615276

Since the t statistic for real estate value is greater than the critical values at both 95% and 90% confidence levels, the null hypothesis can be rejected, and it must be concluded that real estate value is useful in explaining variability in reclamation costs. However, the t statistic for NPV land rental is less than the critical values at 90% and 95% confidence levels, and so the null hypothesis cannot be rejected, and it must be concluded that NPV land rental is not useful in explaining variability in reclamation costs.

Multiple Linear Regression

Since it can be the case that combined independent variables provide a better linear fit than single variables, multiple regression analysis was performed. First, all 5 independent variables were regressed against reclamation costs, and then the three most significant variables were regressed. The multiple regression, however, did not provide any additional information. The three variables that were significant individually in the simple linear regression remained so in the multiple regression. The results of the two multiple regressions are shown in Tables 16 and 17. The F statistic for the 5 variable regression is 15.297720429 and for the 3 variable regression is 13.9506144, so the null hypothesis must be rejected, and both models are useful in explaining some of the variability of reclamation costs.

Table 16. Results of the Multiple Regression: 5 Variables

Y = reclamation costs and X = agricultural region; agricultural classification; surface lease payments; age of the well; and real estate value.					
Constant			2586.46072		
Std Err of Y estimate			2946.65522		
R^2			0.10650246		
No. of Observations			201		
Degrees of Freedom			195		
	Agricultural Region	Agricultural Class	Surface Lease Pmt.	Well Age	Real Estate Value
X Coefficient (β)	-176.06706	206.981805	106596218	-39.80625	4.77227054
Std Err X Coefficient	229.166413	198.94905	0.75839489	18.958707	1.43931816
t statistic	0.7682935	1.04040285	2.18833463	2.0996289	3.31564673

Table 17. Results of the Multiple Regression: 3 Variables

Y = reclamation costs and X = surface lease payments; age of the well; and real estate value.			
Constant	3136.43862		
Std Err of Y estimate	2944.8756		
R^2	0.09842837		
No. of Observations	201		
Degrees of Freedom	197		
	Surface Lease Pmt.	Well Age	Real Estate Value
X Coefficient (β)	1.6430616	-4287464	3.7208615
Std Err X Coefficient	0.75760688	18.5857213	1.08564911
t statistic	2.16875222	2.3068591	3.42731503

Examination of Non-Linear Relationship

Since none of the regressions exhibit very high R^2 values, it is possible that there is some non-linear relationship between reclamation costs and the three significant independent variables. Scatter plots were produced and examined for any evidence of a non-linear relationship (Figures 7, 8 and 9). In each chart, reclamation costs associated with increasing values of the independent value are presented as a dot on the chart. Ideally, one would expect to see some definable pattern in the arrangement of the dots.

The only plot that demonstrated any promise of a non-linear relationship was that for surface lease payments, because it seems that reclamation costs increase at a higher rate at the upper end of the distribution of related surface lease payments. It is possible that the relationship between these variables could be of the form: $y = \beta_0 + \beta_1 x^2$. If this is so, then substituting x^2 for x in a linear regression should improve the goodness of fit and the significance of the variable.

However, this proved not to be the case, since the new regression exhibits an R^2 value of 0.03602301 and the t statistic for x (that is, x^2) at 2.75425852 is less than for the original regression, which exhibited a t statistic of 2.78869782. A non-linear relationship may exist, but it is not possible to demonstrate using this data sample.

Figure 7. Scatter Plot: Surface Lease Payments

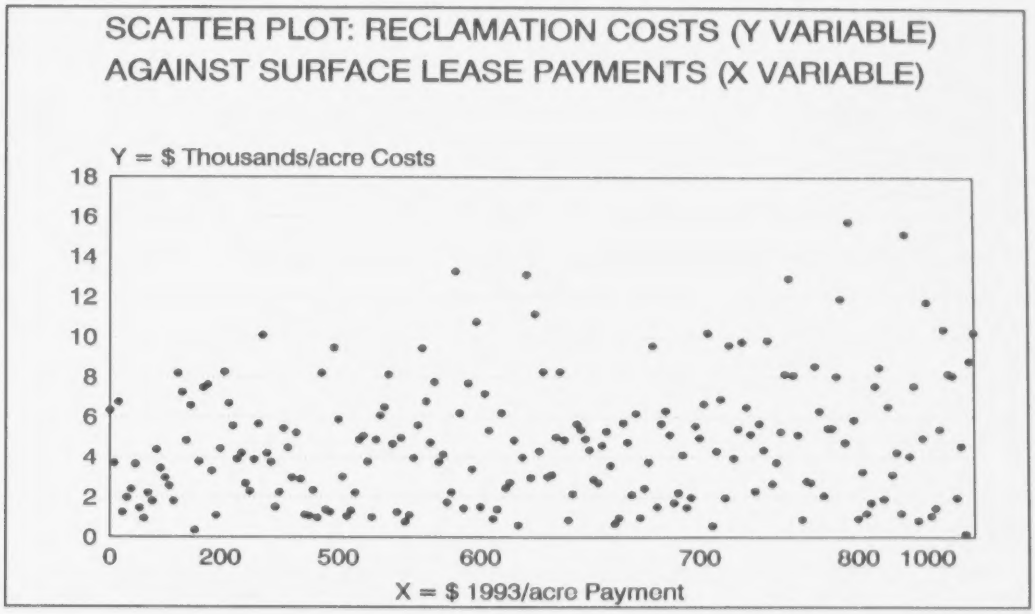


Figure 8. Scatter Plot: Well Age

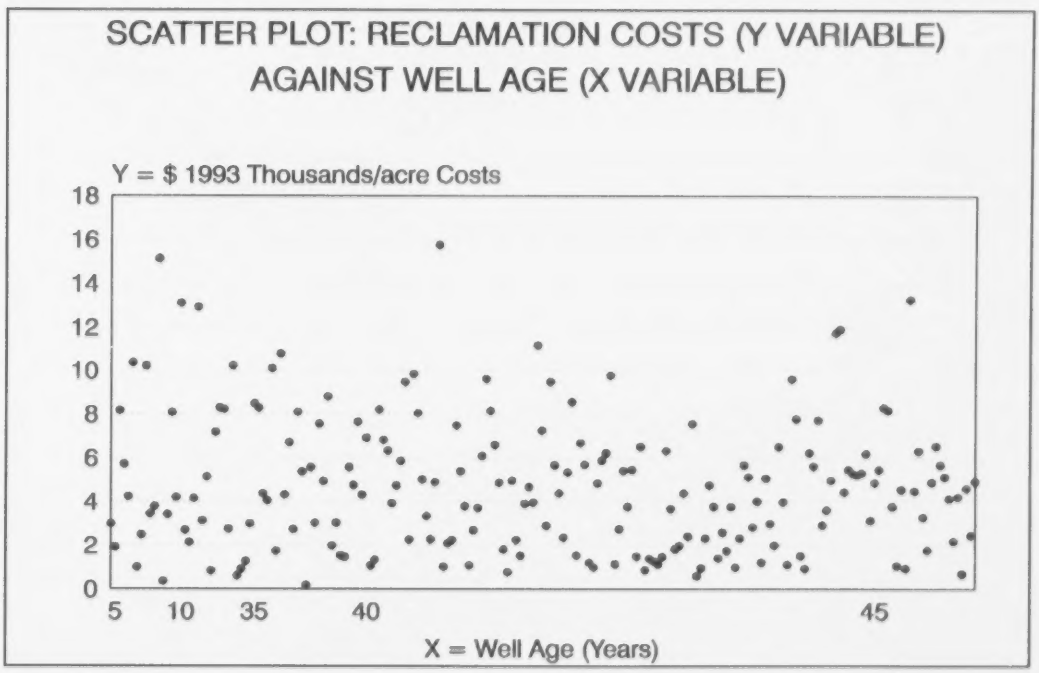
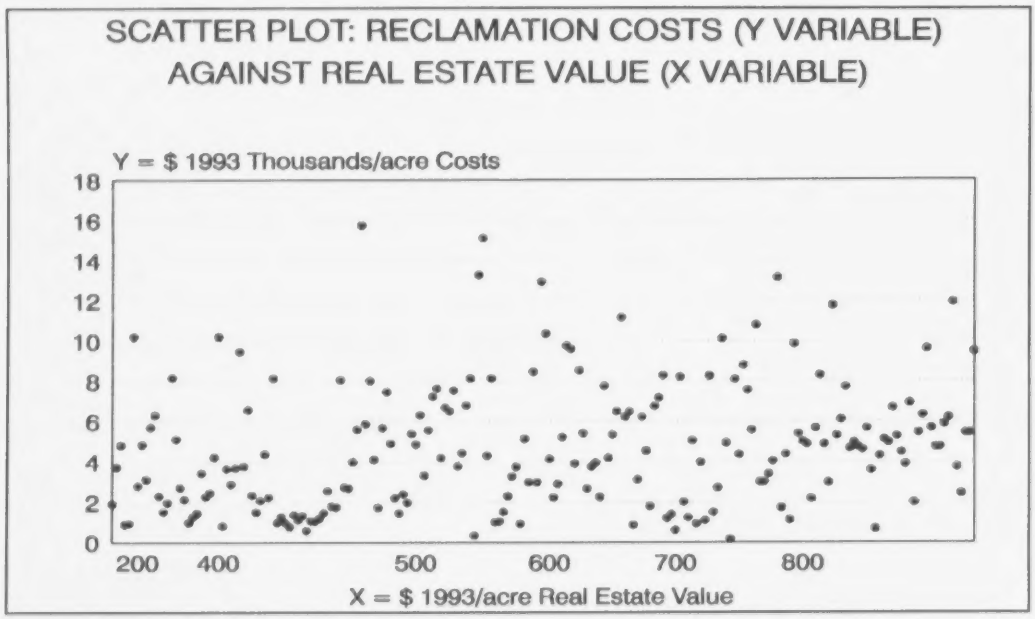


Figure 9. Scatter Plot: Real Estate Value



CONCLUSIONS

This thesis began with two hypotheses concerning the efficiency of regulation of activities on privately-owned land relating to oil and gas development. On the basis of cost-benefit analysis of all tangible variables and some intangible variables, and using the data obtained for this study from both public and private sources, one can conclude that an efficient level of regulation does not appear to exist with regard to either reclamation policy or surface access policy. This conclusion is, however, qualified insofar as there are additional intangible variables that should be investigated and if possible quantified.

Surface Access Regulation

As mentioned, surface lease payments have ratcheted up over time, although the rate has decreased in recent years (Table 7). From the late 1970s to the present, companies seem to have been preoccupied with expedient development of resources to capture the benefits of higher (past) prices at the expense of setting precedents that would be difficult to live with in the event of a price downturn, which is what occurred. As discussed in the literature, there would seem to be some evidence that the "hyperexclusive" property rights exist, under which the landowner could exact monopoly rents from the companies.

The roots of surface access regulation are in the legal and economic foundation of property rights, and in the government's desire to minimize transaction or "organization" costs, recognizing that these could be sufficiently large to be inefficient. However, although the regulation is soundly based, the application of the policy and the regulation should be reviewed in the light of current costs required to be expended. The annual cost of lease payments exceeds the value (benefit) of the land, and this relationship is even more pronounced if total compensation costs are considered. Although some support for large initial and annual compensation payments might exist in economic rather than legal theory as being required to offset externality effects, there would seem to be little support in either economic or legal theory for right-of-entry fees.

Initial and Annual Compensation

Whether government should intercede through regulation to reduce initial and annual compensation is a difficult question. Clearly, the amount of compensation required to offset the externality effects of oil and gas production should remain largely negotiable to increase the possibility of Pareto-efficient solutions. In the case of initial compensation, it is logical that greater compensation would be required to offset externalities associated with the excavation and drilling of the site, as compared to subsequent years when only production equipment would be present.

However, in recognition that the costs of such compensation may be excessive, and present a substantial opportunity cost relative to other, perhaps more economically beneficial investments, the government could "cap" initial and/or annual compensation through legislation similar to the cap on the right-of-entry fee. The issue of a cap on initial or annual payments is contentious, since it would be difficult to define a uniform level of perceived loss that would be appropriate for all individuals. Alternatively, the legal and economic literature suggest that compensation could be limited to a single payment based on the value of the land. Such a solution would be politically difficult to achieve, given the tradition of negotiated annual payments.

Right-of-Entry Fee

The right-of-entry fee is capped at the lesser of $5,000 or $250-$500/acre.

For well sites in this study, averaging 3 acres in size, the right-of-entry fee would be in the order of $1,500. Based on informal discussions with staff at the Surface Rights Board, the fee seems to be intended to compensate the landowner for loss of full control over his or her land, although no documentation could be made available to support this reason. The right-of-entry fee may represent a past concession to agricultural lobbying rather than a real effort to offset in a legal and economic sense some actual loss incurred. Given the high cost of initial and annual compensation, and the lack of a strong theoretical basis, there is a strong argument that this fee should be eliminated.

Impact of Surface Access Regulation on Reclamation Regulation

As mentioned earlier, the termination of surface leases is in most cases effected upon receipt of a reclamation certificate. Once reclamation is completed, the company no longer requires legal access to the site. However, there is currently no legislative provision for renegotiation of surface lease compensation payments during the reclamation period. (Such renegotiation is only authorized at the lease anniversary date every four years under section 27 of the Surface Rights Act.) The continuation of full lease payments under the surface leases during reclamation greatly contributes to incentive effects and avoidance behaviour, as discussed. If, at the outset of reclamation activity, payments were limited to only loss of crop value or an average agricultural rental rate, reclamation goals would

better be met.

Alternatively, the trigger for a reduction of compensation could be provided by data external to the Department of Environmental Protection. For example, any well status of "suspended" as recorded by the Energy Resources Conservation Board that persists beyond a specified period of time could serve as a trigger for Environmental Protection officials to require reclamation activity to be undertaken, and for Surface Rights Board officials to intercede to limit compensation.

By so limiting compensation, it would be possible to reduce the incentive for landowners to continue accepting surface lease payments where reclamation is estimated by companies to be too costly, thus better achieving the primary goal of reclaiming land. This approach has the additional advantage of improving economic efficiency be reducing or eliminating the incentive for landowners to exhibit monopolistic behaviour by delaying approval for reclamation work, in order to receive full surface lease compensation.

Reclamation Regulation

Based on the benefit cost analysis, one can say that an uneconomic level of regulation currently seems to exist, which results in a loss to society. However, this analysis must be qualified based on the following factors:

- reclamation cost data represent the wells and business activities of only one company;
- data for land values (both real estate and land rentals) is based on aggregate published data, and it is unlikely to reflect the actual value of any particular site in Alberta; and
- only one of the intangible benefits of reclamation regulation has been approximated in this study; no extra-market benefits have been considered.

Bearing in mind these qualifications, there is a significant net social loss associated with the current level of reclamation regulation. The implication of this analysis is that there is a net loss to society based on compliance with the standards as currently defined. At an average reclamation cost of $5,000 per acre in 1993, and an average well site size of 3 acres, the loss could be as high as $360 million for the 24,000 outstanding wells that are supposed to be reclaimed over the next 10 years. This is a considerable opportunity cost, considering that the current market value of the land would be about $36 million (at $500/acre).

There are two possible conclusions. First, the standards of reclamation may be too high, which would indicate a need for a more cost-effective approach to establishing the regulatory standards. Second, the choice of standards as a regulatory instrument may be incorrect. In either case, there are some recommendations that can be made to modify existing policy to increase technical and allocative efficiency.

RECOMMENDATIONS

Based on this qualified analysis, the individual and combined impact of surface access and reclamation regulation culminates in welfare loss to society. There are two issues. First, there is the additive compliance cost burden of two regulations relative to benefits achieved. Second, the bundling of surface access and reclamation regulation creates negative incentive effects, which increases the level of inefficiency. Potentially, the combined cost impact at some future date could be severe enough to create or accelerate a downturn in the health of the industry, possibly with a greater loss to the provincial economy than is currently perceived.

In developing recommendations for improving regulations based on the above conclusions, it is necessary to observe:

- the desirability of government intervention in situations where disputes may be resolved by private exchange;
- transaction costs of such private exchanges;
- the regulatory goals to be accomplished;
- opportunity cost, in terms of total social welfare; and
- the legal and economic principles that should form the foundation of policy and regulations.

Some of the following recommendations reflect some of the concepts already discussed in reference to Lave and Gruenspecht (1991).

Establish a Trigger for Initiation of Reclamation Activity

An independent trigger such as the persistence of a well "suspended" status could serve as an initial point to require or at least evaluate the need for reclamation activity, thus preventing companies from avoiding their obligations. This trigger could also serve as a point at which surface lease payments are reduced.

Limit Compensation During Reclamation

While there is some logic that leases should not be terminated prior to completion of reclamation work (legal access is necessary for such work to be effected), the level of annual compensation payable under the lease during the reclamation period should be limited by statute or regulation.

Eliminate Right-of-Entry Fee

As discussed, the legal and economic basis for this fee is not clear. It does not seem to provide compensation for any tangible externalities, and provision for offsetting intangible externalities already exists within the initial and annual compensation payments.

Examine Cost-Effectiveness of Reclamation Standards

Standards should be reviewed to determine the degree of incremental production (marginal benefit) created by each level of reclamation activity (marginal cost). Such investigations could be conducted jointly by industry,

government and Universities or colleges. As well, the cost effectiveness of having industry or the landowner perform certain reclamation tasks should also be investigated. While some landowners willingly assist in reclamation, others do not, which increases the overall social opportunity cost of the regulation.

Limit Application of Existing Standards

As was discussed with regard to Superfund, closer scrutiny of costs results in less consistent application of a uniform policy or set of standards. While there may be overriding priorities (eg. long-term solutions or health risk), some discretion is allowed in meeting the overall level of standards. Such an approach would probably only be feasible in the sense of establishing "risk-benefit" goals whereby some types of categories of environmental damage would be allowed if it could be shown that costs of fully ameliorating the site would be prohibitive relative to land value. The ideal approach, a benefit-cost assessment of each site, simply would not be feasible.

Tax Companies Where Standards Are Not Met

At the conclusion of a site inspection based on whatever standards are in place, full release from the reclamation activity would be allowed and the surface lease would be terminated. There would be a tax imposed on the company based on failure to attain a sufficient degree of reclamation. In practice, this is not unlike the existing process, whereby site inspections are

conducted to grant reclamation certificates or determine additional work. There are several potential efficiency gains with this approach: increased compliance, faster resolution to the reclamation process by preventing delays caused by landowner approval, and reduced administrative costs to industry and government (eg. no need to apply for and process Chairman's certificates). Where reclamation is extremely costly, and a company opts to pay the tax, the compensation for incomplete reclamation should be shared between the landowner and the public.

FURTHER RESEARCH

Additional research should be undertaken in the following areas to build on this study.

- A more complete data sample is needed. Given the organizational complexities of the companies discovered in this study it is suggested that all data be collected in-house by the researcher, with the cooperation of the companies; questionnaires such as used in this study proved to be problematic. The companies do support studies of this nature, but cannot spare the staff to properly identify and collect relevant data.

- Published data on land values is needed in a disaggregated state and on a fairly complete basis for exact or proximal lands on which well site

reclamation costs have been gathered. One possibility is to undertake data collection jointly with the Department of Agriculture, Food and Rural Development as part of their annual real estate and rental questionnaire surveys. Alternatively, municipal tax data or data from private real estate companies may be useful.

- Land use information is needed on a exact or proximal lands for which reclamation cost data has been gathered. The use of agricultural classifications as a proxy was not useful. It is proximal land use patterns that are supposed to drive the reclamation activities and costs, and this needs to be tested with better data. Again, this will likely entail personal effort in accessing corporate files, or going to the field offices and interviewing the corporate landmen.

- Some detailed examination should be made of specific cases where higher than average surface lease payments and higher than average reclamation costs are occurring, to determine if they are the result of landowner "bargaining power", or if there is a different pattern prevailing across companies that should be addressed through regulatory change.

- Contingent valuation studies of the landowners should be undertaken to better evaluate the existence and option value attributable to reclaimed lands and the externality compensation levels that are expressed in surface lease

payments. While this may prove to be difficult to do, any regulatory change is unlikely to be successful without some effort designed to quantify personal impact of oil and gas activities, especially if payment reductions are contemplated. Further, it would provide additional information generally about the system being studied.

- Study should be undertaken jointly by government and Universities or colleges, possibly with industry involvement to establish more cost-effective reclamation standards.

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APPENDIX I Example Surface Lease Agreement

The document presented below is an exact duplication of the information contained in a surface lease agreement that was provided by an industry source. Unfortunately, the original document is both oversize and not of a quality suitable for inclusion in the thesis due to multiple facsimile transmissions.

SURFACE LEASE

This indenture of Lease made the _____ day of _____

BETWEEN:_____

of _____, in the Province of Alberta,

- and -

WHEREAS the Lessor is the registered owner (or entitled to become the registered owner under an agreement for sale of unregistered transfer or otherwise) of an estate in fee simple, subject, however, to the exceptions, conditions, encumbrances, liens and interests contained in or noted upon the existing Certificate of Title of all in that certain parcel or tract of land situate, lying and being in the Province of Alberta and described as follows:

(hereinafter referred to as "the said lands"); and

WHEREAS the Lessor has agreed to lease and grant a certain portion of the said lands to the Lessee for the purposes and upon the terms and conditions hereinafter set forth:

NOW THEREFORE THIS INDENTURE WITNESSETH:

THE LESSOR at the rental hereinafter set forth, HEREBY LEASES to the Lessee all and singular those parts or portions of the said lands shown outlined in red on the sketch or plan hereto attached (hereinafter called "the demised premises"), to be held by the Lessee as tenant for the term of Twenty-five (25) years from the date hereof for any and all purposes and uses as may be necessary or useful in connection with all its operations.

YIELDING AND PAYING UNTO THE LESSOR:

(a) for the first year the sum of _____ ($_____) Dollars, (the receipt of which sum is hereby acknowledged), which sum includes compensation in full for rental, severance, inconvenience, and damage done to the demised premises,

(b) for each subsequent year the sum of _____ ($_____) Dollars, payable annually in advance of the anniversary of the date hereof in each year during the currency hereof.

THE LESSOR HEREBY COVENANTS AND AGREES TO AND WITH THE LESSEE:

1. Taxes Paid by Lessor:

That the Lessor will promptly pay and satisfy all taxes, rates and assessments that may be assessed or levied against the said lands during the continuance of this Lease save where such are to be paid by the Lessee.

2. Quiet Enjoyment:

The Lessor has good title to the said lands as hereinbefore set forth, has good right and full power to grant and Lease the said lands, and privileges in manner aforesaid, and that the Lessee, upon observing and performing the covenants and conditions on the Lessee's part herein contained, shall and may peaceably possess and enjoy the demised premises and the rights and privileges hereby granted during the said term and any extension thereof without any interruption or disturbance from or by the Lessor or any other person claiming by, through or under the Lessor.

3. Renewal:

That if the Lessee be not in default in respect of any of the covenants and conditions contained in this Lease at the date of expiration of the term of Twenty-five (25) years hereinbefore mentioned then this Lease shall be renewed automatically and the term extended for a further period of Twenty-five (25) years at an annual rental calculated from time to time as hereinafter provided for that portion of the term subsequent to the first year thereto. Such extended term shall be subject to all the provisions hereof including this provision for renewal.

THE LESSEE HEREBY COVENANTS AND AGREES TO AND WITH THE LESSOR:

4. Fencing:

During the continuance of this Lease, to erect and put upon the boundaries of the sites and roadways constructed or placed by the Lessee on the demised premises a good substantial fence if so requested by the Lessor, or if required by the Lessee, and to replace all fences which the Lessee may have removed for its purposes and repair all fences which it may have damaged, and if when so required by the Lessor, to provide a proper livestock guard at any point of entry upon the said lands used by it and, upon the use thereof, to close all gates.

5. Taxes Payable by Lessee:

To pay all taxes, rates and assessments that may be assessed or levied in respect of any and all machinery, equipment, structures and works placed by the Lessee, in, on, over or under the said lands.

6. Compensation for Damages:

To pay compensation for damage done by its servants, agents or assigns which without restricting the generality thereof shall include the growing crops, fences, buildings or other improvements of the Lessor upon the said lands other than the demised premises.

THE LESSOR AND THE LESSEE DO HEREBY MUTUALLY COVENANT AND AGREE WITH EACH OTHER AS FOLLOWS:

7. Review of Rental:

Notwithstanding anything contained in this Lease, upon the request of either party to this Lease, the amount of rent payable in respect to the demised premises shall be subject to review at the end of five years from the date hereof and at the end of each succeeding five year period. Such request shall be in writing and given to the other party at least ninety (90) days prior to the commencement of the period in respect of which the review of rent is sought. In case of any disagreement as to the amount of rent to be payable or any other matter in connection therewith, the same shall be determined by the arbitration legislation in force.

8. Surrender:

The Lessee shall have the right at any time and from time to time to surrender and terminate this lease by written notice to the Lessor, provided however, that there shall be no refund to the Lessee of any rental which may have been paid in advance.

9. Reduction of acreage:

Notwithstanding anything in the immediately preceding clause hereof contained, the Lessee may form time to time and at any time surrender any part or portion of the demised premises by giving the Lessor a revised plan of the portion or portions thereof retained, and provided that the rental shall be no less than hereinbefore provided.

10. Removal of Equipment:

The Lessee may at all times during the continuance of this Lease remove or cause to be removed from the demised premises all buildings, structures, fixtures, casing in wells, pipelines, material and equipment of whatsoever nature or kind which it may have placed on or in the demised premises or in any area to be surrendered.

11. Discharge of Encumbrances:

The Lessee may at its option pay or discharge all or any part of any balance owing under any Agreement for Sale or Mortgage, or of any tax, charge, lien or encumbrance of any kind or nature whatsoever which may now or hereafter exist on or against or in any way affect the said lands, in which event the Lessee shall be subrogated to the rights of the holder or holders thereof, and may in addition thereto, at its option, reimburse itself by applying on account of repayment of the amount so paid by it the rentals or other sums accruing to the Lessor under the terms of this Lease.

12. Assignment by Lessee:

The Lessee may delegate, assign or convey to other persons or corporations, all or any of the powers, rights, and interests obtained by or conferred upon the Lessee hereunder, and may enter into all agreements, contracts, and writings and do all necessary acts and things to give effect to the provisions of this clause.

13. Default:

Notwithstanding anything herein contained to the contrary, the Lessee shall no be in default in the performance of any of its covenants or obligations under this Lease, including the payment of rental unless and until the Lessor has notified the Lessee of such default and the Lessee has failed to commence action to remedy the same, within thirty (30) days of the receipt of such notice.

14. Payments and Notices:

All payments and notices to be made or given hereunder may be made or given personally or by registered mail addressed to the party to whom the payment or notice is to be made or given, and when mailed, any such payment or notice shall be deemed to be made or given to, and received by, the addressee Seven (7) days after mailing thereof,

postage prepaid.

15. **Addresses:**

Unless changed by written notice the addresses of the parties shall be:

Lessee:_____

Lessor:_____

These presents and everything herein contained shall inure to the benefit of and be binding upon the Lessor, his heirs, executors, administrators, successors and assigns and upon the Lessee, its successors and assigns.

_____, the above mentioned Lessee accepts this Lease of the said lands, to be held by it as tenant, and subject to the conditions, restrictions and covenants above set forth.

IN WITNESSETH WHEREOF the Lessor has hereunto set his hand and seal and the Lessee has executed by its authorized representative in that behalf, the day and the year above written.

SIGNED, SEALED AND DELIVERED
in the presence of:

_____
Witness

_____
Witness

_____ Per:_____
Witness

APPENDIX II Conservation and Reclamation Standards

The Code updates the 1982 "Minimum Reclamation Requirements for Public and Private Lands in Alberta". It outlines factors you should consider if you are not required to obtain a Conservation and Reclamation Approval.

For more detailed information contact Reclamation Officers in Alberta Environmental Protection.

The Code promotes and encourages:

1. The return of a disturbed site to a land capability equivalent to the pre-disturbance land capability. This capability must be sustainable under normal management.

2. Acceptance of pre-development soil, landscape and vegetation conditions as the standard for post-development conditions.

3. Identification of potential soil, landscape and vegetation conservation concerns through pre-construction site assessments and pre-planning.

4. Conservation of the essential characteristics of the project site (e.g., soil, landscape, vegetation) to minimize post-construction remedial requirements.

5. Awareness of the value of soil, the sensitivity of soil to disturbance, and the difficulty of reclaiming degraded soils.

6. Awareness of the importance of the native vegetation on a project site, and the need for protection and rapid reestablishment of vegetation that is compatible with the adjacent land.

7. Monitoring all activities to ensure a complete record of conservation, degradation, mitigation and reclamation events.

8. On-site supervision of development and reclamation activities by personnel responsible for environmental quality control.

9. Reclamation on as much of the disturbed area as possible each year to minimize land disturbance.

10. Site assessments following reclamation which provide a complete evaluation of soil, landscape and vegetation conditions and compare them to pre-development conditions, prior to application for a reclamation certificate.

SPECIFIC FACTORS TO CONSIDER

Project Planning

- **Communication** - Communicate with the landowner, occupant and Conservation and Reclamation Council from the start to the finish of the project.
- **Location** - Locate site to minimize impact on resources (e.g., soil, vegetation, water and wildlife).
- **Planning** - Develop plans for conservation, reclamation, and waste handling and disposal.
- **Timing** - Time operations considering climatic, soil, vegetation and wildlife concerns.

Site Preparation and Operation

- **Disturbance** - Keep all disturbances to a minimum. Obtain approval from Alberta Environmental Protection for disturbances on public land.
- **Soil** - Properly salvage and store materials. Keep an accurate record of storage locations.
- **Waste** - Put contaminant spill contingency measures in place before operations commence. Dispose of all wastes in an approved manner.
- **Access** - Put all necessary gates, fences and authorized access in place with clear signage.

Reclamation

- **Contamination** - Cleanup and dispose of, or remediate, contaminants to meet Alberta Environmental Protection requirements.
- **Landscape** - Recontour the site to original grade and drainage. Control erosion.
- **Soil Replacement** - Replace soils in same sequence as found before disturbance unless otherwise directed by the Conservation and Reclamation Council.
- **Compaction** - Correct soil compaction.
- **Revegetation** - Use approved revegetation species that are compatible with the intended land use. Control noxious weeds.

Monitoring

- **Sustainability** - Ensure land capability is sustainable under normal management.

Reclamation Certificate

The Alberta Environmental Protection and Enhancement Act requires you to reclaim land and to obtain a reclamation certificate. Refer to the appropriate Reclamation Certificate Application form and criteria for the information required when applying for a certificate. Ensure that all site conditions (landscape, soil, vegetation) meet the required criteria before requesting a certificate.

RECLAMATION CRITERIA FOR WELLSITES AND ASSOCIATED FACILITIES

The fundamental principle of these criteria is that any changes caused by project activities should be measured against the original or representative site conditions. In most cases, the land, soil and vegetation adjacent to your site will be used as a comparison. However, in special cases, you may have to find representative land, soil and vegetation a short distance from your site; your reasons for doing this must be explained to the Conservation and Reclamation Council at the inquiry.

The document is divided into two sections:

- Level I - certification criteria; and
- Level II - problem identification and characterization.

The certification criteria describe the allowable changes in site conditions that will still maintain equivalent capability.

Drilling wastes and other oilfield wastes must be properly disposed of according to Energy Resources Conservation Board guidelines. All contamination must be treated prior to certification. Specific criteria for the assessment and remediation of contaminants (e.g., metals, sterilants, organic chemicals) will be provided by Alberta Environmental Protection.

The certification criteria apply to wellsite leases, access roads, and off-site borrow pits, sumps, and campsites. They do not apply to facilities that are left in place (e.g., roads, pads, dugouts, etc.) with the landowners approval.

When the reclamation officers inspect your site for certification they will be confirming the information you supplied. *If problems are noted, subsequent requests for site inspections will receive lower priority than first time requests, therefore it is to your advantage to ensure that a site is ready for certification before submitting an application.*

These criteria combine Conservation and Reclamation Council field experience and published documents. The latter include Soil Quality Criteria Relative to Disturbance and Reclamation (Alberta Agriculture, 1987), Land Capability Classification For Arable Agriculture in Alberta (Alberta Agriculture, 1987), reports from the Alberta Soils Advisory Committee and the Reclamation Research Technical Advisory Committee, existing government handbooks and guidelines, and textbooks.

1. LEVEL I - CERTIFICATION CRITERIA

Level I criteria will be used to judge reclamation success and grant the reclamation certificate. You must supply information relative to the criteria on the Wellsite Reclamation Certificate Application form. In Level I, field assessments are used, rather than laboratory data; however, you should undertake sampling and laboratory analyses when problems are apparent, or when spills have occurred or sterilants have been used.

1.1 LANDSCAPE

Landscape criteria will be assessed by comparing the site with the pre-disturbance conditions or adjacent land. Differences between the site and the adjacent land must not interfere with normal land use.

DRAINAGE

- Site drainage should be consistent with the original patterns, direction and capacity or compatible with the surrounding landscape.

EROSION

- No more erosion gullies or blowouts than on adjacent land allowed.

CONTOUR

- Contour and roughness must conform and blend with adjacent contours.
- Older, well-vegetated and stabilized sites may be exempt from this requirement. Authorization from the Conservation and Reclamation Council must be obtained.

STABILITY

- No visible evidence of slope movement, slumping, subsidence, or tension cracks allowed.

COARSE FRAGMENTS (Gravel, stone, rock)

- Private Land
  - ≤10 cm in diameter - an increase of 10% in surface cover (for example, if the control has 5% cover your site may have up to 15% cover).
  - >10 cm in diameter - 0% increase in surface cover.
- Public Land - an increase of 10% in surface cover.

DEBRIS

- No industrial or domestic debris allowed.
- No woody debris (roots, slash) allowed unless previously authorized by the Conservation and Reclamation Council.

1.2. TOPSOIL/SURFACE SOIL

For private land and cultivated public land, "topsoil" is defined as all "A" horizon (Ah, Ahe, Ae, and Ap) material within the soil profile. Ae or AB horizons will have to be salvaged with the topsoil or separately salvaged (as a second lift). When the Ae or AB horizons are salvaged with the topsoil, the control for the quality comparison must be a mix of the topsoil and the Ae or AB horizons.

Organic soils and soil layers will also be salvaged and replaced. Shallow organic layers (≤15 cm; L-F-H layers) will be incorporated with the topsoil. Deeper organic layers will be assessed to a maximum depth of 40 cm.

Quantity and quality of replaced topsoil will be assessed on a 20 m x 20 m grid, inset 5 m from the lease boundaries (approximately 25 locations per hectare) on the disturbed area. The individual assessment points must be representative of the 20 m x 20 m block they are in. On access roads, one paired location (an on-road sample and off-road control) must be assessed every 30 m. Highly diverse landscapes will require more assessment locations.

For non-cultivated public land, "surface soil" will be defined as a specific depth of soil to be salvaged and replaced. Depth of replaced surface soil will be assessed on a 20 m x 20 m grid, inset 5 m from the lease boundaries (approximately 25 locations per hectare) on the disturbed area. The individual assessment points must be representative of the 20 m x 20 m block they are in. On access roads, one paired location must be assessed every 250 m. Highly diverse landscapes will require more assessment locations.

The topsoil/surface soil depth criteria take into account the various legislated soil salvage and replacement requirements that have been in effect at different times. In some cases, you may have salvaged topsoil/surface soil when you were not required to; you are encouraged to replace these materials over your site.

A minimum of four control sites (one on each side of the disturbed area) must be assessed to provide comparisons for the disturbed area; more control sites will provide a better assessment of the natural variability in the undisturbed soils. On access

roads, control sites (off the road) will be assessed at the same locations as the access road is assessed. Where control site characteristics vary significantly, you should not use the average values for your comparisons; rather, you should use each control to represent a portion of the site or access road.

TOPSOIL/ SURFACE SOIL QUANTITY

Private Land and Cultivated Public Land

- Average replaced topsoil depth must be:
  - 90% of control for sites constructed in 1993 or later;
  - 80% of control for sites constructed from 1983 to 1992;
  - 70% of control for sites in CLI* Class 1 to 4 lands constructed prior to 1983;
  - 50% of control for CLI* Class 5 and 6 lands constructed prior to 1983.

  * CLI refers to the Canada Land Inventory and, in this case, focuses only on the soil capability. It does not include the climate or landscape limitations.
- 90% of the assessment sample sites must be ≥80% of the average replaced depth on the site.
- 100% of the assessment sample sites must be ≥50% of the average replaced depth on the site.
- No assessment sample site with less than 80% of the average replaced depth may be adjacent to another assessment sample site with less than 80% of the average replaced depth.

Non-cultivated Public Land

- Average replaced surface soil depth must be ≥70% of the depth stated in the disposition or the depth specified in writing by the Conservation and Reclamation Council.

TOPSOIL QUALITY	<u>Private Land and Cultivated Public Land</u>
	• When compared side by side with representative control samples from similar depths under similar light and moisture conditions, the assessment point samples must be in the same class as the controls as defined below. Improvements in the soil quality class are acceptable.
	  • % admixing of subsoil (no more than 20% more subsoil in the sample than in the control). Note: drilling wastes are generally <u>not</u> acceptable in topsoil because soil quality problems have been identified in the past and because we do not have a good understanding of the long term effects on soil quality. However, some waste types in some soil types may be appropriate provided the waste plus subsoil meets the admixing criteria and all the other topsoil quality criteria.
	  • texture (classes - see Figure 1).
	  • aggregate size (classes - <2 cm; 2 cm to 5 cm; >5 cm to 10 cm). Note: no aggregates greater than 10 cm are allowed unless similar size aggregates are present in the control soil. No pulverised soil is allowed.
	  • aggregate strength (classes - friable, firm, hard).
	  • layering (classes - no difference in extent; evident difference in extent; obvious difference in extent).
	• Each of the parameters is assessed at each assessment point. The assessment point passes only when all the criteria are met. The site passes only when all the assessment points pass.
	• When most or all of the topsoil depth is made up through the use of amendments, the topsoil quality criteria may be waived. All amendments must be approved by the Conservation and Reclamation Council.

SALINITY	• No increase in visible salts.

COARSE FRAGMENTS (gravel, stones, rocks)	• <u>Private Land</u>
	  • ≤10 cm in diameter - an increase of 10% (by volume).
	  • >10 cm in diameter - 0% increase (by volume).
	• <u>Public Land</u> - an increase of 10% (by volume).

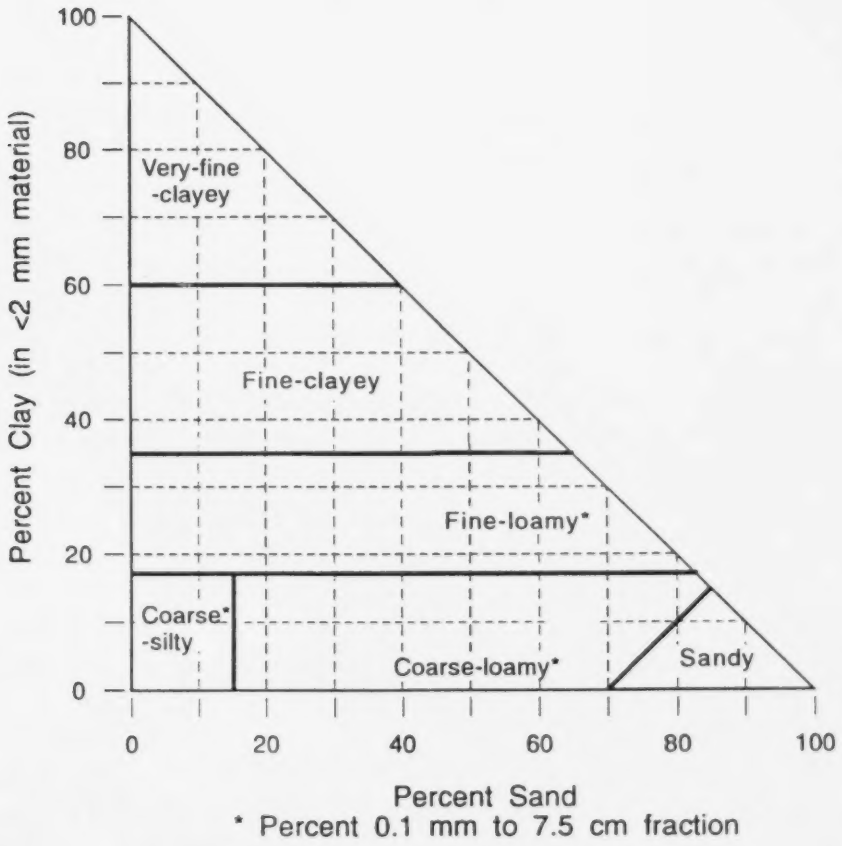


Figure 1. Texture classes

COMPACTNESS

- Use a shovel, screwdriver, or penetrometer to assess compactness.
- Maintain or improve the quality of the following ratings:
  - Non-compacted - penetrates easily;
  - Moderately compacted - penetrates with moderate effort;
  - Very compacted - penetrates with difficulty.

1.3. SUBSOIL

Subsoil will be evaluated at a minimum of five locations to a depth of 70 cm from the soil surface. On the lease, the locations must include excavated or intensively used areas such as the sump, well centre, flare pit, access road entry point, and tank area, if present. On the access road, randomly select five of the topsoil assessment locations. Subsoil samples will be compared to control samples from the same depth.

SALINITY

- No increase in visible salts.

COARSE FRAGMENTS (gravel, stones, rocks)

- Private Land - an increase of 10% (by volume).
- Public Land - an increase of 10% (by volume).

COMPACTNESS

- Use a shovel, screwdriver, or penetrometer to assess compactness.
- Maintain or improve the quality of the following ratings:
  - Non-compacted - penetrates easily;
  - Moderately compacted - penetrates with moderate effort;
  - Very compacted - penetrates with difficulty.

1.4. VEGETATION

Private land sites will not be certified without vegetation unless you provide detailed soil physical and chemistry data (Level II assessment) or vegetation performance information from previous years. Public land sites will not be certified without vegetation. In the case of producing wellsites where sterilants have been used, or where spills (hydrocarbon, salt) have occurred, vegetation which meets the criteria below must be present at the time of certification. Contact the Conservation and Reclamation Council to determine how long vegetation must grow on the site before you can apply for a certificate.

Reclaimed sites should not require any additional or special management in comparison to adjacent or representative lands to be sustainable or to provide similar crop yields.

SPECIES COMPOSITION	• Revegetation species and species composition should be compatible with original or adjacent vegetation.
VIGOUR	• Plant vigour should be similar to original or adjacent vegetation.
HEIGHT and DENSITY	• ≥80% of adjacent growth* based on a visual assessment.
COVER‡	• Where the adjacent vegetation is similar, ≥80% of adjacent ground cover based on a visual assessment. Note: for erosion control purposes, there must be a minimum of 40% ground cover on the site. • Where there is no adjacent vegetation or the adjacent vegetation is different, ≥80% ground cover based on a visual assessment unless otherwise authorized by the Conservation and Reclamation Council in writing. • Litter can be included in the ground cover assessment. • The required cover must be evenly distributed on the site.
ROOTING	• No obvious rooting restrictions (e.g., reduced root length, root mats, compressed roots, roots along the cracks only, no roots) in topsoil or subsoil.
BARE AREAS	• Frequency and extent of bare areas should not be greater than original or adjacent vegetation.

* Use when crop/vegetation on the site is the same as that surrounding the site. When the crops/vegetation are different, use vigour only.

‡ Does not apply to annual crops. Density is a better measure.

2. LEVEL II - PROBLEM IDENTIFICATION AND CHARACTERIZATION

Level II will be used to help identify and characterize problem areas that require further reclamation prior to application for certification. *These characteristics will not be used to determine certification;* however, if a problem is identified, the Conservation and Reclamation Council may require you to evaluate any or all of these characteristics. *You may also be required to provide data for the landscape, soil or vegetation criteria in Level I or any other environmental factors.*

2.1 LANDSCAPE

SLOPES • Final slope gradients must not exceed the original slope gradients by more than 20%.

EROSION • The rate of erosion on the site must not exceed the off-site rate.

2.2 SOIL

In the Level II assessment, the subsoil must be evaluated to a minimum depth of 100 cm from the soil surface. More sampling locations may be required for both topsoil (surface soil) and for subsoil.

ORGANIC MATTER • Organic matter content (in percent) must be at least 80% of the control value.

CHEMISTRY • Soil pH, salinity and sodicity must be consistent with original or representative land. There should be no negative change in rating (Good, Fair, Poor, Unsuitable).

White Area

	GOOD	FAIR	POOR	UNSUITABLE
pH	6.5 to 7.5	5.5 to 6.4 or 7.6 to 8.4	4.5 to 5.4 or 8.5 to 9.0	<4.5 or >9.0
Salinity (EC dS/m)	**Topsoil** <2	2 to 4	4 to 8	>8
	Subsoil <3	3 to 5	5 to 10	>10

Sodicity (SAR)	<4	4 to 8	8 to 12	>12

Green Area

	GOOD	FAIR	POOR	UNSUITABLE
pH	5.0 to 6.5	4.0 to 5.0 or 6.5 to 7.5	3.5 to 4.0 or 7.5 to 9.0	<3.5 or >9.0
Salinity (EC dS/m)	**0 to 30 cm** <2 **30 to 70 cm** <3	2 to 4 3 to 5	4 to 8 5 to 8	>8 >8
Sodicity (SAR)	<4	4 to 8	8 to 12	>12

TEXTURE and STRUCTURE

- Maintain or improve quality of the following categories:

Topsoil/Surface Soil	GOOD	FAIR	POOR
• Texture	FSL, VFSL, L, SiL, SL	CL, SCL, SiCL	S, LS, SiC, C, HC
• Soil Aggregate Size	<2 cm diameter	2 to 5 cm diameter	>5 to 10 cm diameter
• Soil Aggregate Structure	Granular or fine blocky	Powdery or medium blocky	Massive or large clods present
• Soil Aggregate Strength (Consistence)(m=moist; d=dry)	Friable	Loose, firm (m) or hard (d)	Very firm (m), or very hard to rigid (d)

Subsoil	GOOD	FAIR	POOR	VERY POOR
• Texture	FSL, VFSL, L, SiL, SL	CL, SCL, SiCL	S, LS, SiC, C, HC	
• Soil Aggregate Size	<2 cm diameter	2 to <10 cm diameter	10 to 30 cm diameter	>30 cm diameter
• Soil Aggregate Structure	Granular or fine blocky	Blocky	Large blocky	Massive or bedded
• Soil Aggregate Strength (Consistence)(m=moist; d=dry)	Friable	Slightly firm (m) or hard (d)	Very firm (m) or very hard (d)	Extremely hard or rigid (d)

2.3 VEGETATION

Quantitative assessment of Level I criteria may be required. Methods for the assessment will be provided by the Conservation and Reclamation Council.

APPENDIX III Industry Benefit-Cost Survey Questionnaire

INDUSTRY QUESTIONNAIRE: BENEFIT COST STUDY OF RECLAMATION ACTIVITIES ON PRIVATE LANDS, 1993 Page ___ of ___

Part I: Well Data

Well Name [1]	Location (Legal Description)	Well Type [2]	Reclaimed Area [3]	Well Site Size [4]	Reclamation Period [5]	Completion Date [6]	Reclamation Certificate? [7]

1 If you would rather not specify a name, please identify each well with a number. Begin numbering with 1, on the next page continue with 11, and so on.
2 Please indicate the type of well at the time of reclamation: producing oil, producing gas, suspended oil, suspended gas, or abandoned.
3 If the area being reclaimed is not the same size as the well site please indicate the size of the area actually being reclaimed.
4 Please indicate the well site size in hectares.
5 Please indicate the period in months and the year during which reclamation activities took place, eg. June 1992 to August 1992.
6 Please indicate when the reclamation activities (see Part II of the questionnaire for a list of activities) were completed; for wells where work is ongoing, indicate the expected completion date.
7 Please indicate (yes or no) whether or not a reclamation certificate has been received for this site.

Please provide any comments you feel are relevant to the information presented:_____

_____

Contact person: _____

INDUSTRY QUESTIONNAIRE: BENEFIT COST STUDY OF RECLAMATION ACTIVITIES ON PRIVATE LANDS, 1993 **Page ___ of ___**

Part II: Surface Access Costs

Well Name [1]	Entry Fee [2]	Date of Entry [3]	Compensation [4]	Lease [5]	Period [6]	Lease terminated? [7]

1 If you would rather not specify a name, please identify each well with a number. Begin numbering with 1, next page continue with 11, and so on.
2 Entry refers to the right of entry fee.
3 Refers to the date (month and year) that right of entry was received.
4 Compensation refers to the initial compensation payment during the first year of the lease for use of the land.
5 Lease refers to ongoing annual or monthly compensation payments (please indicate monthly or annual) commencing from the date of right of entry.
6 Period refers to the payments made under 5. Please specify the period of the lease payments in total months or years.
7 Please indicate yes or no.

Please identify any other surface access costs required to be paid and the reason:_____.

Please provide any comments you feel are relevant to the information presented:_____.

Contact Person:_____

INDUSTRY QUESTIONNAIRE: BENEFIT COST STUDY OF RECLAMATION ACTIVITIES ON PRIVATE LANDS, 1993

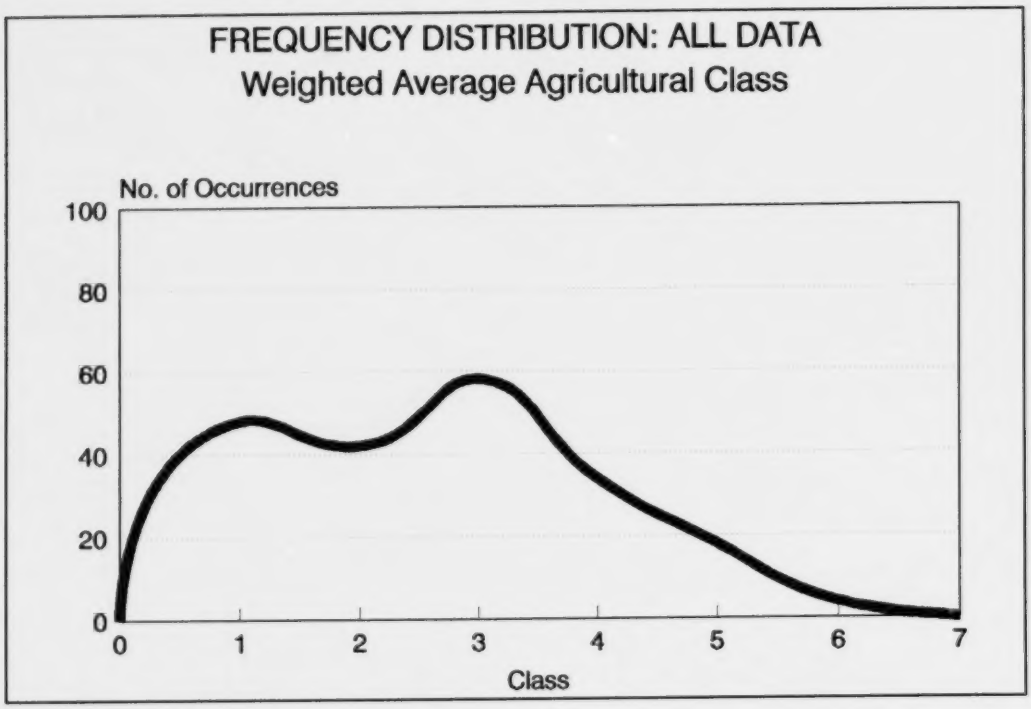
Part III: Reclamation Cost Data

RECLAMATION ACTIVITY	Well: Location:	Well: Location:	Well: Location:	Well: Location:
Adjacent Land Use [1]				
Site Assessment (sampling, analysis, evaluation)				
Site Reclamation: 1) Surface facilities/equipment removal 2) Disposal of contaminants: On-site remediation Off site disposal 3) Landscaping: Recontouring Rough grading 4) Compaction treatment 5) Soil Replacement 6) Revegetation 7) Other (Specify):_____				
Was any of this work required to be repeated? Please indicate the category of activity, the additional cost, and the time required to do the work.				

1 Please indicate the surrounding land use: cultivated (crops), cultivated (grazing), unmodified (grazing), unmodified (not used for agriculture).

Contact person: _____

APPENDIX IV Frequency Distributions for Regression Variables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Weighted Average Agricultural Class
No. of Occurrences
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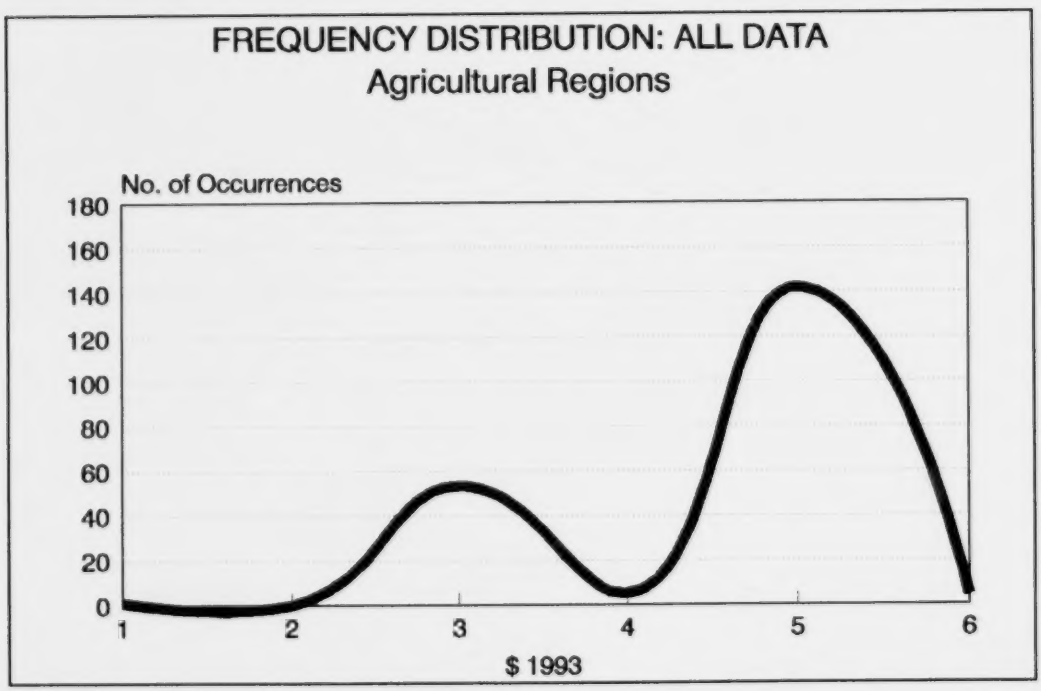
60
40
20
0
0
1
2
3
4
5
6
7
Class


FREQUENCY DISTRIBUTION: ALL DATA
Agricultural Regions
No. of Occurrences
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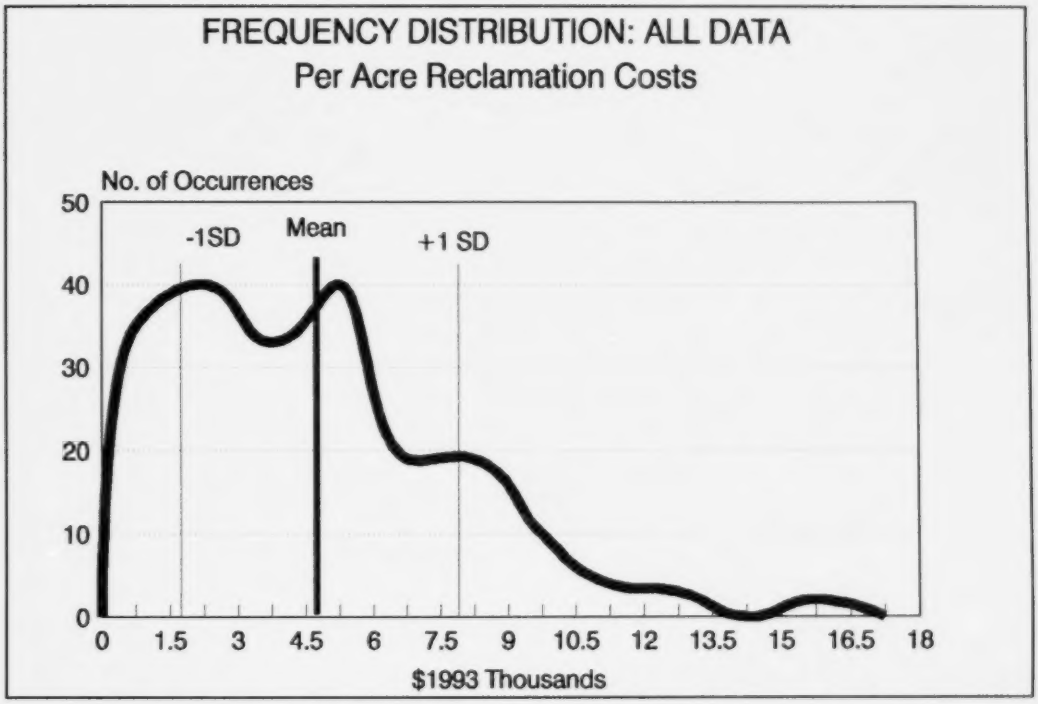
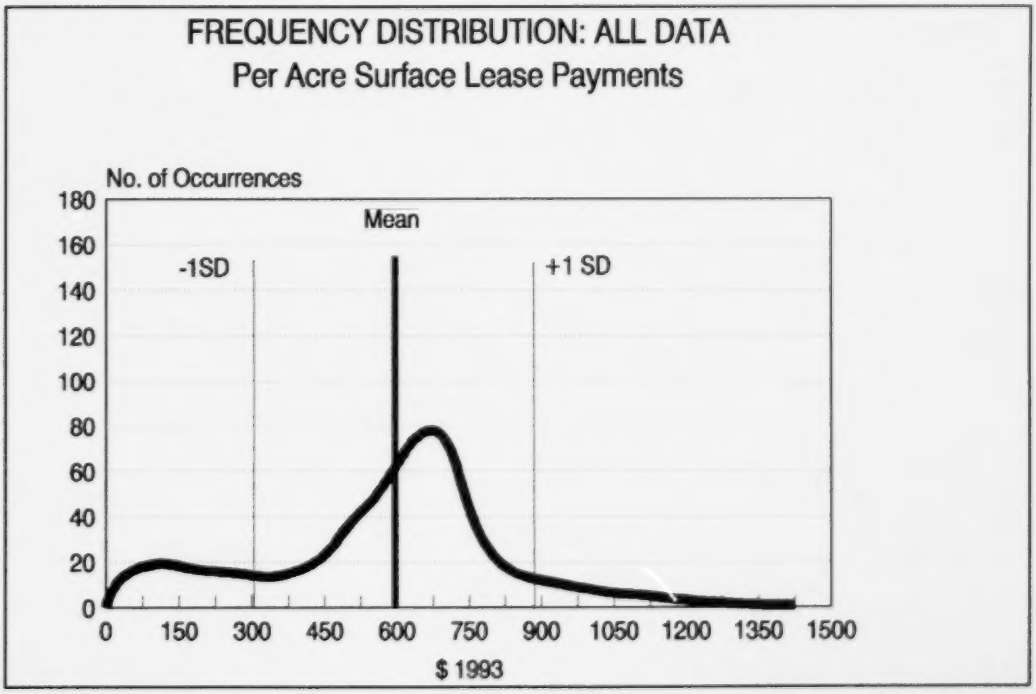
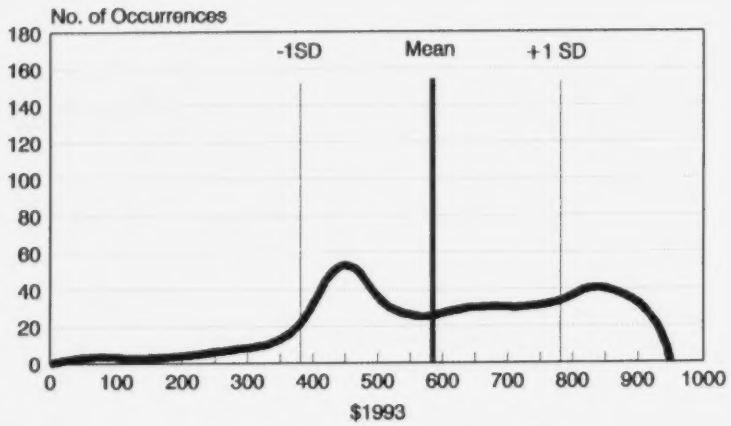
160
140
120
100
80
60
40
20
0
1
2
3
4
5
6
$ 1993


FREQUENCY DISTRIBUTION: ALL DATA
Per Acre Reclamation Costs
No. of Occurrences
50
40
30
20
10
0
-1SD
Mean
+1 SD
0
1.5
3
4.5
6
7.5
9
10.5
12
13.5
15
16.5
18
$1993 Thousands


FREQUENCY DISTRIBUTION: ALL DATA
Per Acre Surface Lease Payments
No. of Occurrences
180
160
140
120
100
80
60
40
20
0
Mean
-1SD
+1 SD
0
150
300
450
600
750
900
1050
1200
1350
1500
$ 1993

FREQUENCY DISTRIBUTION: ALL DATA
Per Acre Real Estate Value



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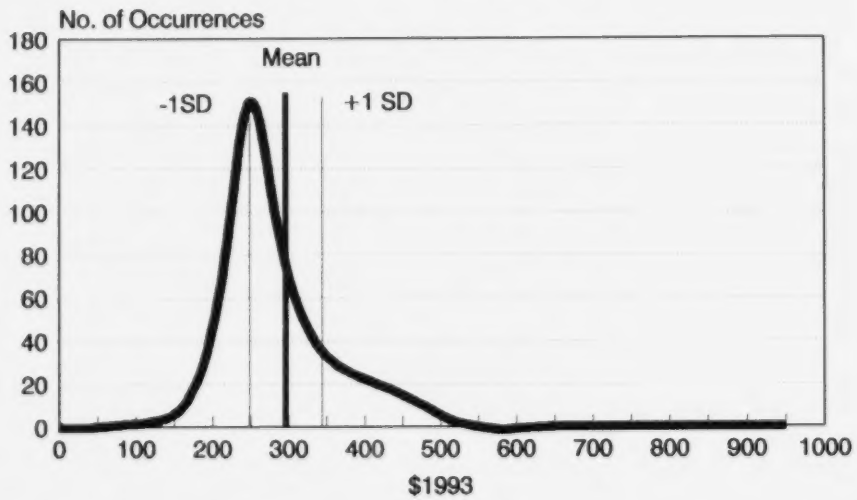
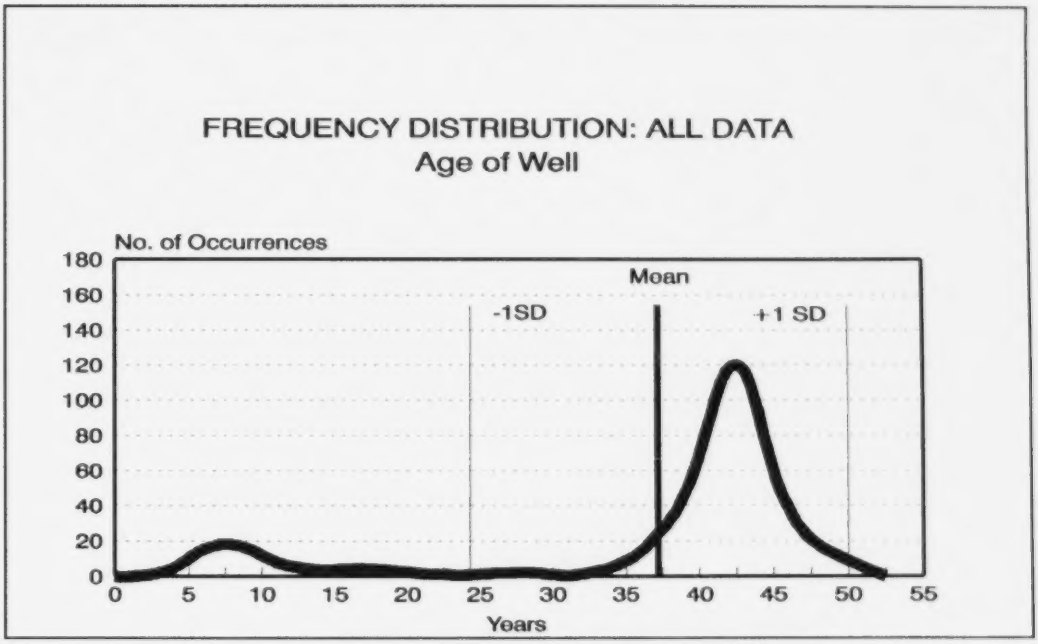
Per Acre NPV Rental

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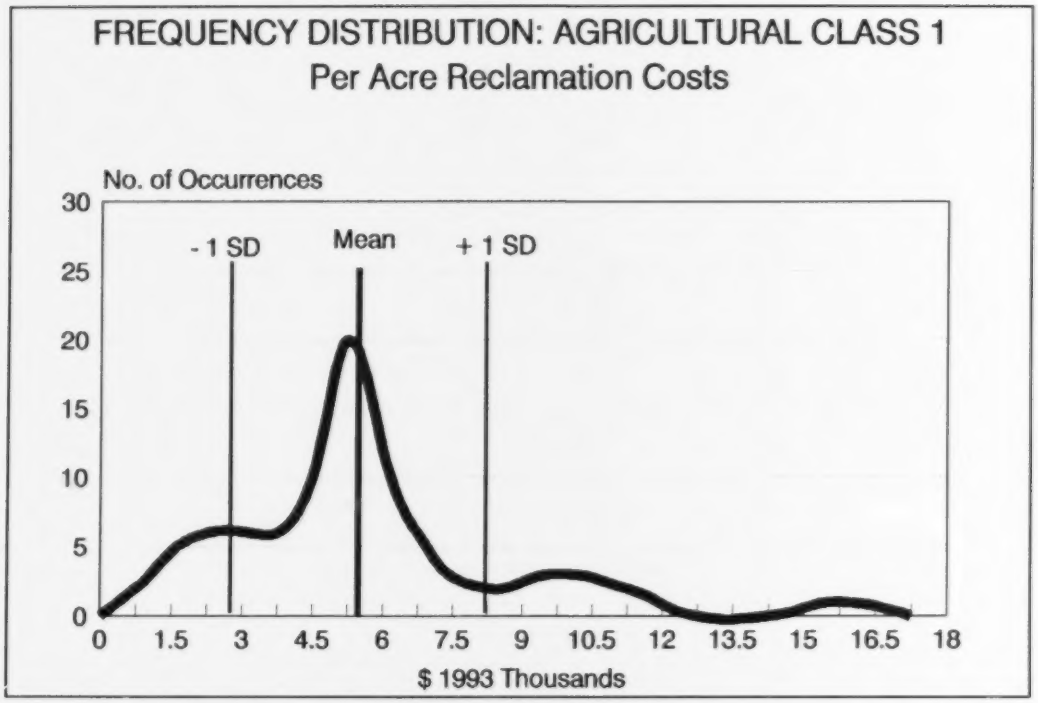
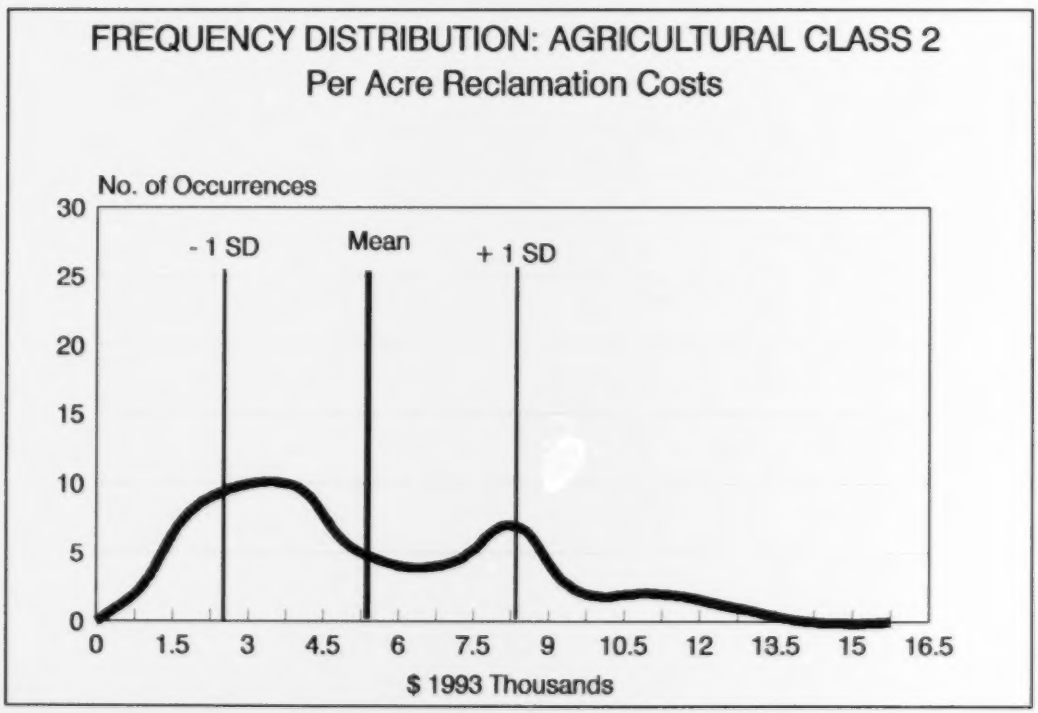
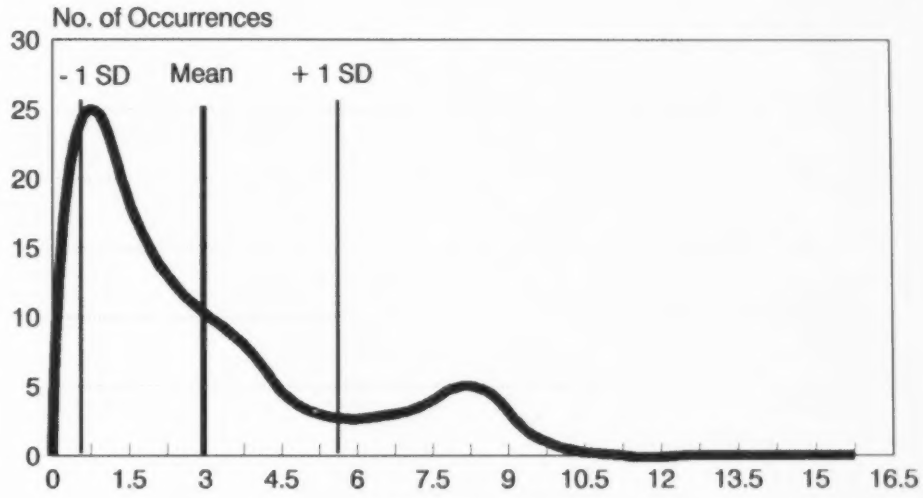
Age of Well
No. of Occurrences
180
160
140
120
100
80
60
40
20
0
Mean
-1SD
+1 SD
0
5
10
15
20
25
30
35
40
45
50
55
Years


FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 1
Per Acre Reclamation Costs
No. of Occurrences
30
25
20
15
10
5
0
- 1 SD
Mean
+ 1 SD
0
1.5
3
4.5
6
7.5
9
10.5
12
13.5
15
16.5
18
$ 1993 Thousands


FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 2
Per Acre Reclamation Costs
No. of Occurrences
30
25
20
15
10
5
0
- 1 SD
Mean
+ 1 SD
0
1.5
3
4.5
6
7.5
9
10.5
12
13.5
15
16.5
$ 1993 Thousands

FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 3
Per Acre Reclamation Costs



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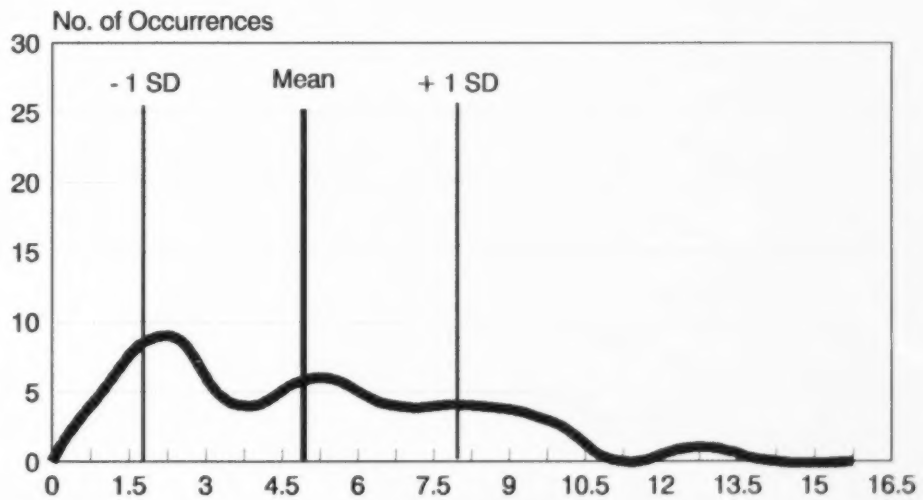
Per Acre Reclamation Costs



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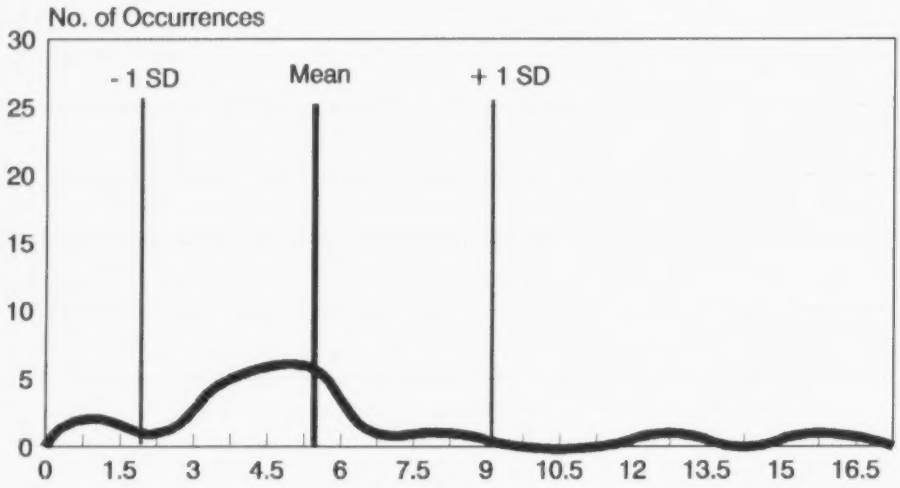
Per Acre Reclamation Costs



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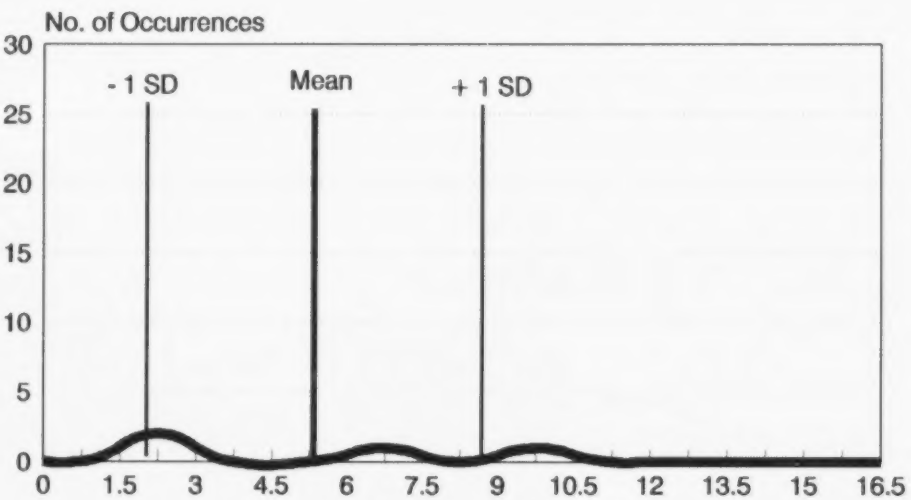
Per Acre Reclamation Costs



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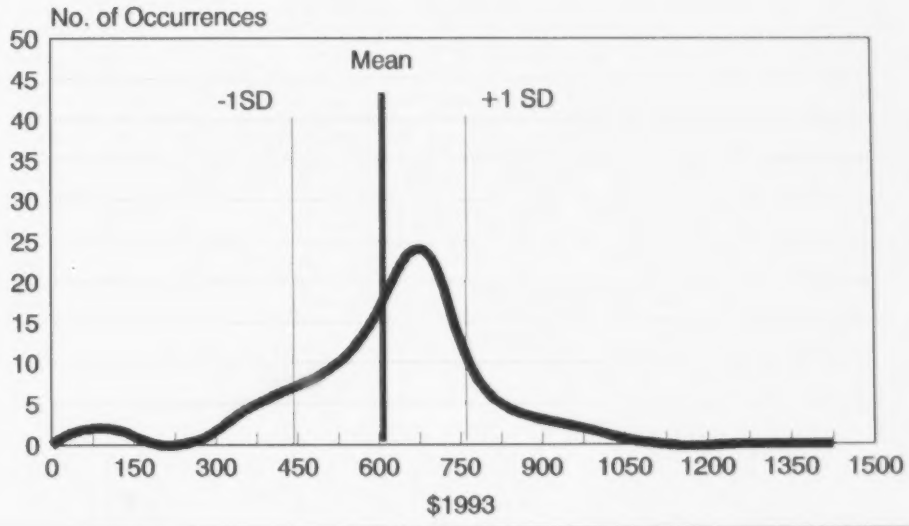

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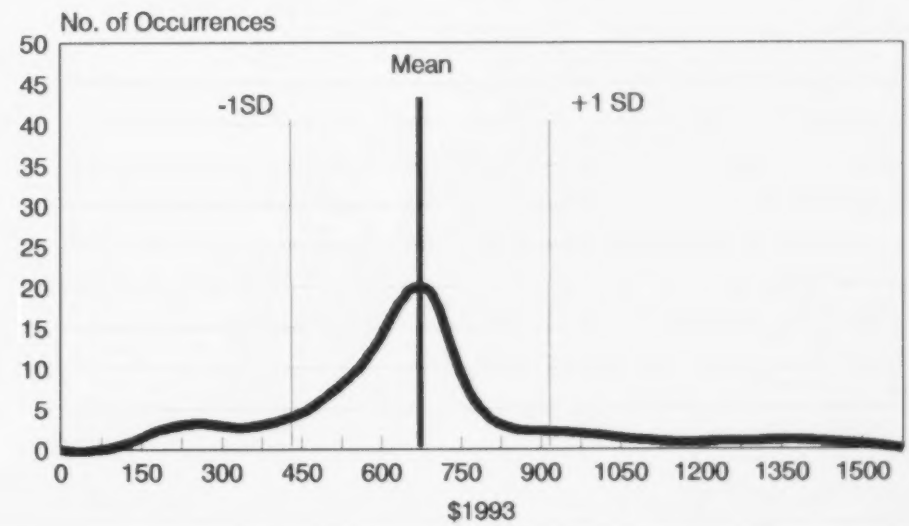
Surface Lease Payments



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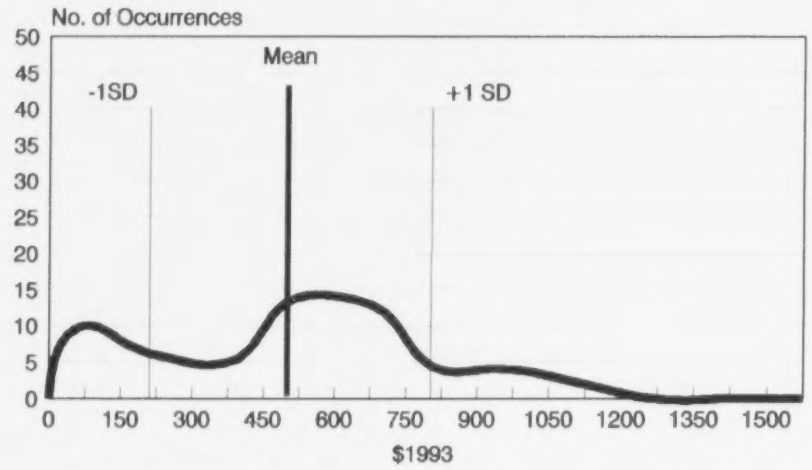
Surface Lease Payments



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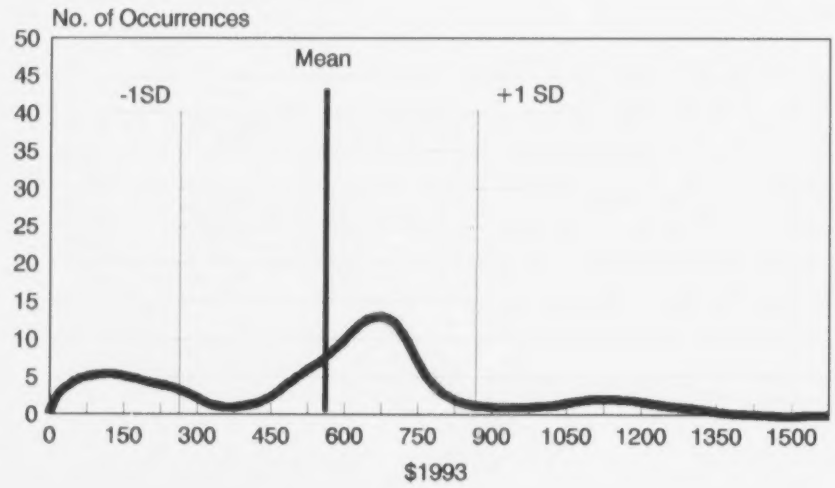
Surface Lease Payments



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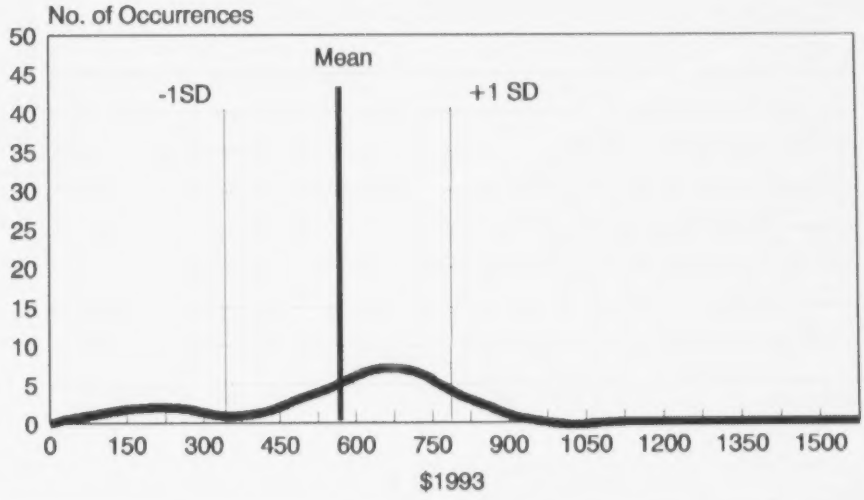
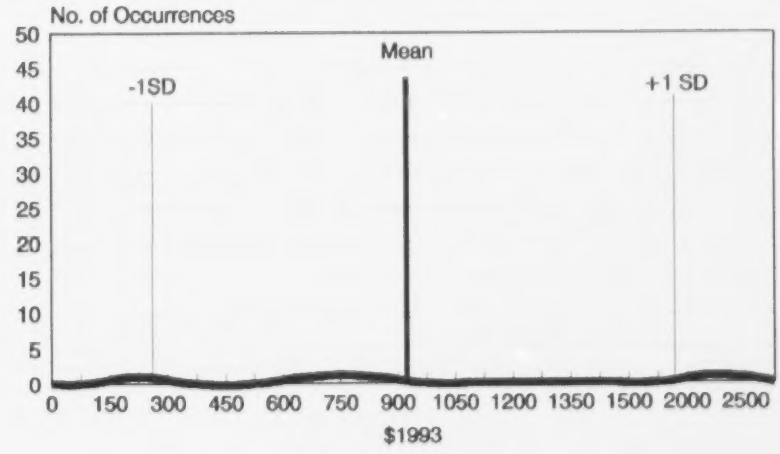
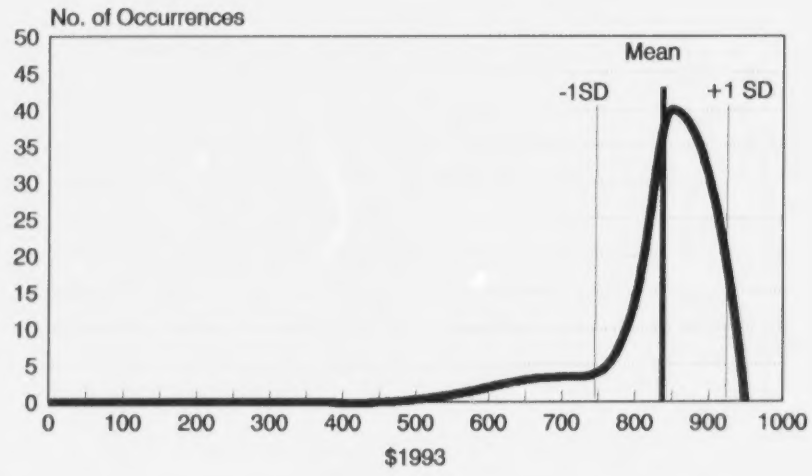
Surface Lease Payments



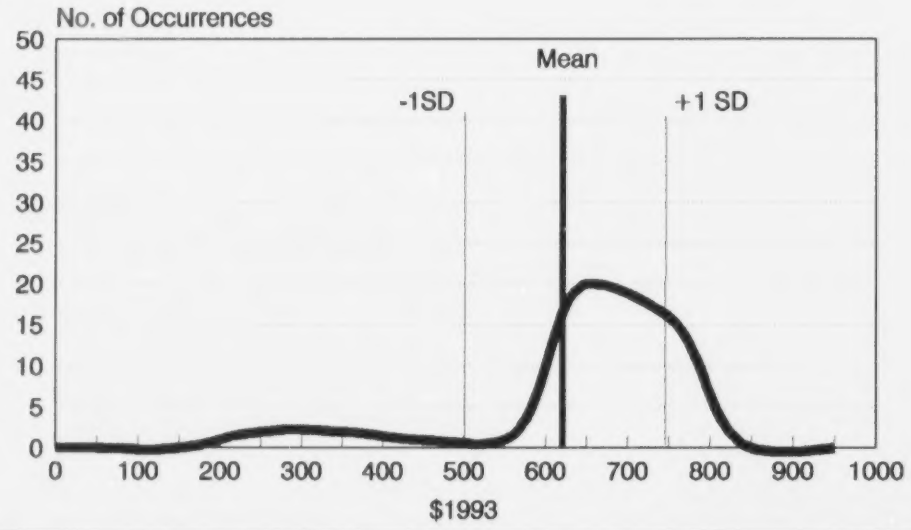
FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 6
Surface Lease Payments

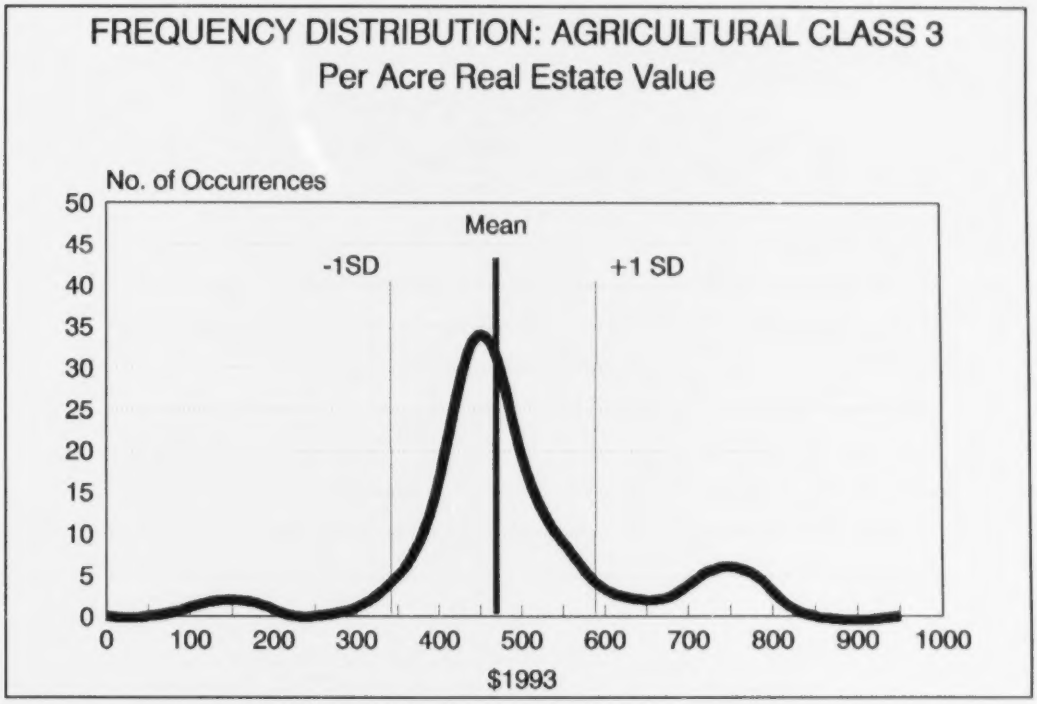


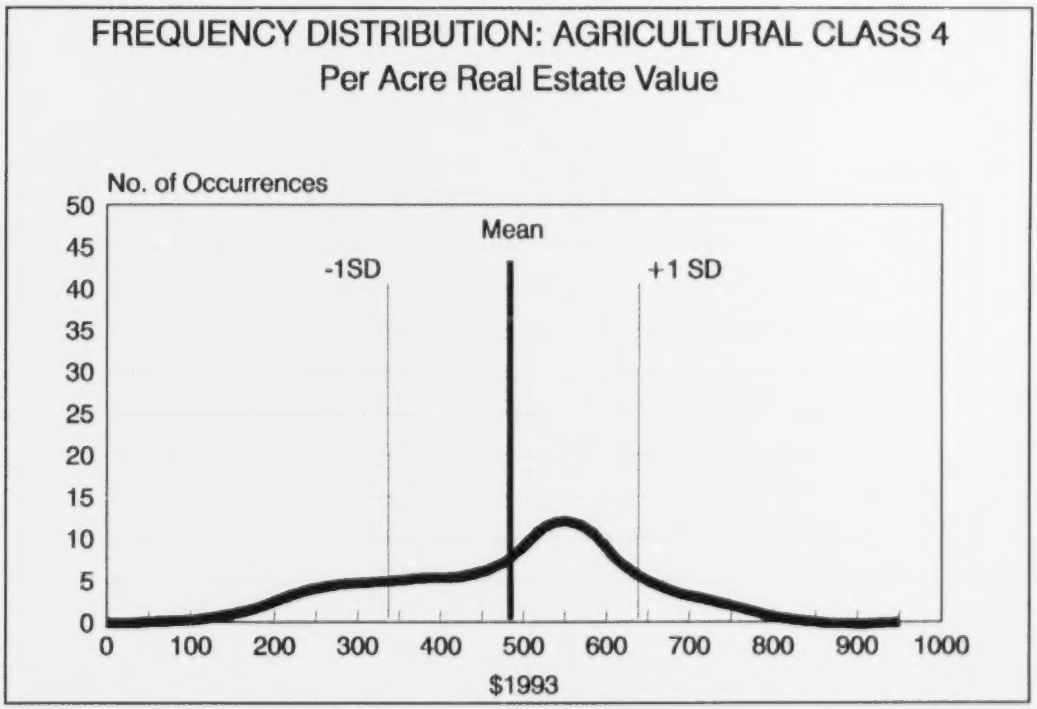
FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 1
Per Acre Real Estate Value



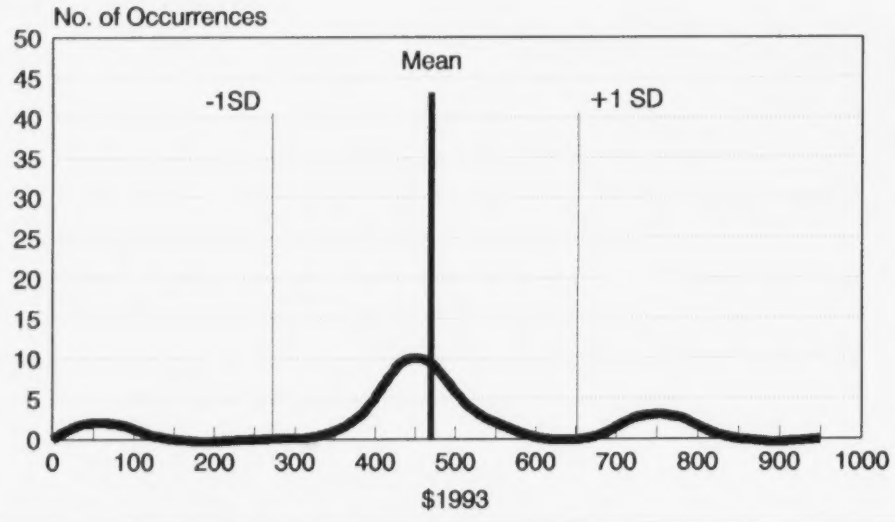
FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 2
Per Acre Real Estate Value



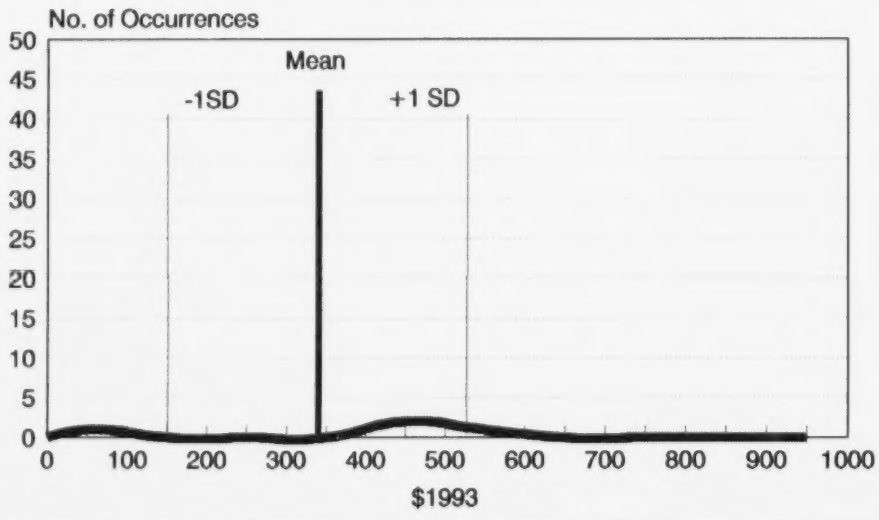

FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 3
Per Acre Real Estate Value
No. of Occurrences
50
45
40
35
30
25
20
15
10
5
0
Mean
-1SD
+1 SD
0
100
200
300
400
500
600
700
800
900
1000
$1993


FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 4
Per Acre Real Estate Value
No. of Occurrences
50
45
40
35
30
25
20
15
10
5
0
Mean
-1SD
+1 SD
0
100
200
300
400
500
600
700
800
900
1000
$1993

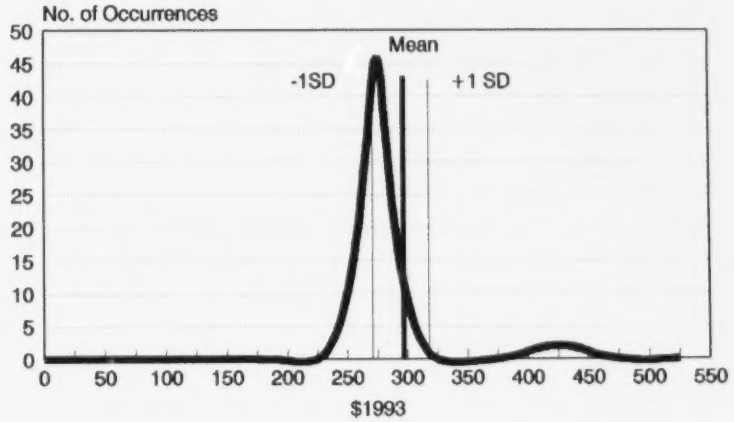
FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 5
Per Acre Real Estate Value



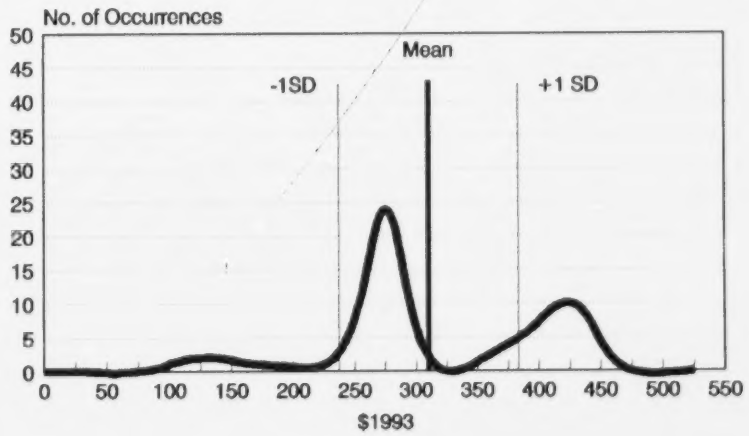
FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 6
Per Acre Real Estate Value



FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 1
Per Acre NPV Rental



FREQUENCY DISTRIBUTION: AGRICULTURAL CLASS 2
Per Acre NPV Rental



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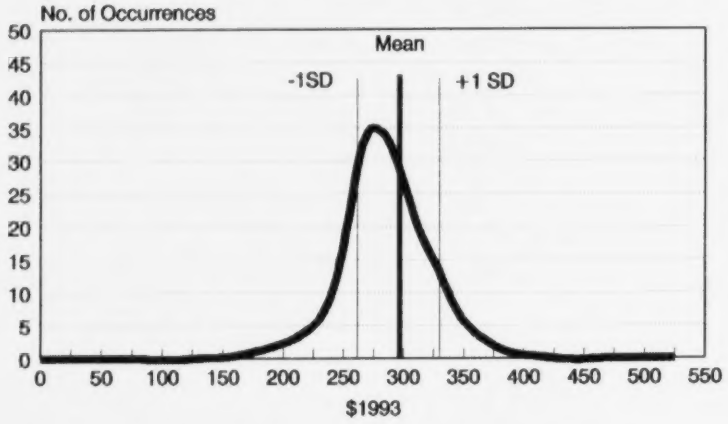
Per Acre NPV Rental



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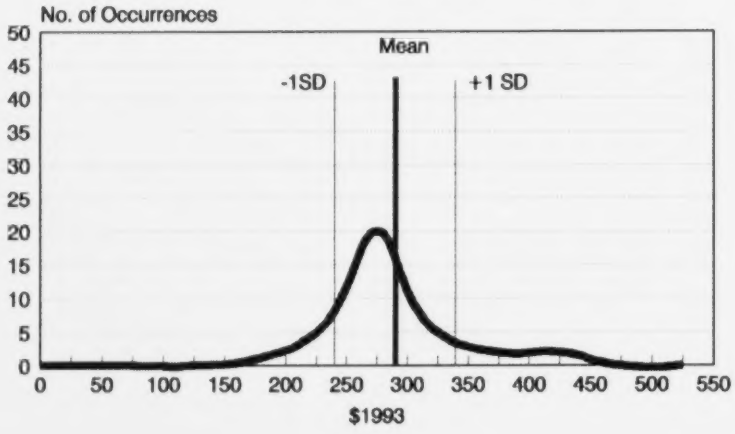
Per Acre NPV Rental



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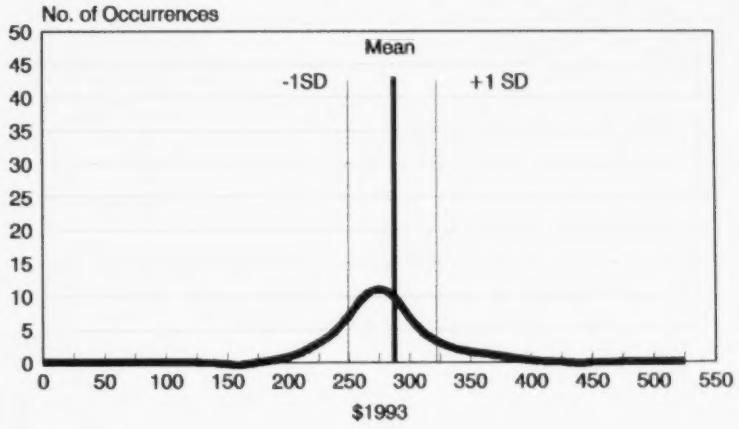
Per Acre NPV Rental



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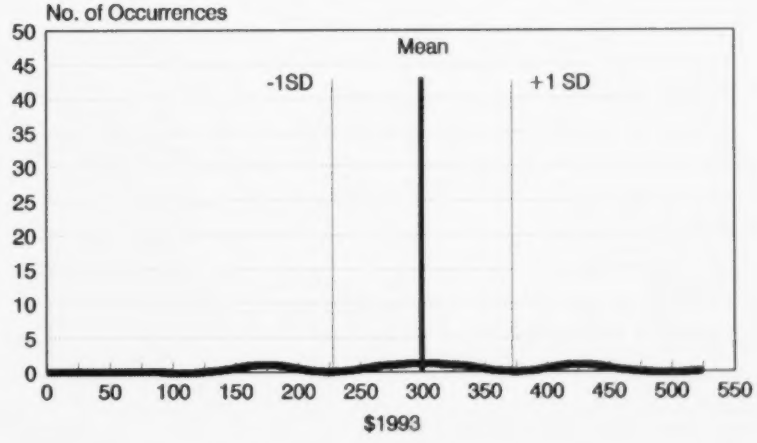
Per Acre NPV Rental



APPENDIX V Agricultural Regions of Alberta

Alberta Agriculture

STATISTICS
BRANCH